SHARED CONTROL OF NATURAL RESOURCES (SCOR)

Data, Capacity Building, and Networking Needs for the Use of Geographical Information Systems in Agricultural Research

International Irrigation Management Institute (IIMI)
Sri Lanka Country Programme
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SCOR seeks to increase the users' share of control of natural resources in selected watersheds through partnerships between the state and users that contribute to greater production while conserving the natural resources base. SCOR will promote integrated planning for the use of land and water resources in two pilot watersheds with spread effects to other areas. The SCOR project is a collaborative effort of the Government of Sri Lanka, the United States Agency for International Development (USAID) and the IIMI.

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Position paper - International Irrigation Management Institute (IIMI)

1. BACKGROUND

1.1 IIMI's mission, Long term and short term objectives

IIMI is an autonomous, nonprofit, international research organization established in 1984 with a global mandate to conduct research, provide opportunities for professional development and communicate information on irrigation management. IIMI has been a member of the Consultative Group of International Agricultural Research (CGIAR) since 1990(IIMI 1993:2).

IIMI's Mission is to foster the development, dissemination, and adoption of lasting improvements in the performance of irrigated agriculture in developing countries. IIMI has set the following three goals to achieve this mission.

1. To generate knowledge to improve irrigation management and policy making;
2. To strengthen national research capacity in the field of irrigation management; and
3. to support the introduction of improved management and policy making (IIMI 1993:3)

IIMI's short term objective is to enter into partnerships with those responsible for managing irrigation systems, government and non-governmental irrigation agencies, and national research institutes to undertake collaborative research, institutional strengthening and information dissemination on lasting improvements in irrigated agriculture.

Its long term objectives are,

1. to increase knowledge in improving the performance in irrigation systems through collaborative research under the following themes.
   a) Sustainable management of water delivery and disposal
   b) Assessing and improving the performance of irrigated agriculture

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[1]A paper presented at ARENDAL II workshop on UNEP and CGIAR co-operation on 09.05.95 to 11.05.95 in Arendal, Norway.

[2]Monitoring & Evaluation Specialist of Shared Control of Natural Resources Project of Sri Lanka Field Operations, IIMI.

c) Promote local management of irrigated systems
d) Improving public irrigation organizations
e) Sector–level management of irrigated agriculture

2. to improve the capacities of national research institutions in collaborating countries to conduct irrigation management related research and to conduct management related tasks in irrigated agriculture.

1.2 Institutional frame work, Linkages and budget

IIMI's headquarters is located in Sri Lanka. It runs research programs in India*, Bangladesh* Nepal, Sri Lanka, and the Philippines* in the South and Southeast Asia, Pakistan and Sudan in West Asia and Northeast Africa, in Morocco*, Burkina Faso, Niger and Nigeria* in North and West Africa, and in Mexico and Columbia in Latin America.

An International Board of Directors provides policy and direction to the institute. It consists of fourteen distinguished persons coming from various countries around the world. A Director General serves as the Chief Executive and reports to the Board. Its current staff strength is 354 including 31 international staff.

IIMI is supported by contributions from donor members of the CGIAR. The donor agencies include African Development Bank, Asian Development Bank, Commission of the European Communities, Ford Foundation, USAID, Japan, International Development Research centre, International Fund for Agricultural Development, United Nations Development Programme, and the World Bank (IIMI 1993:15). IIMI operates with an annual Budget of about US$ 10 million.

2. SPATIAL DATA AND INFORMATION MANAGEMENT CAPACITIES

2.1 Main Objectives, mandates,users, and documented outputs

Objectives

The general objective of IIMI's collection and use of spatial data for its research programs is to extract information to support planning, implementation and monitoring of collaborative interventions to achieve the desired changes in irrigated agriculture.

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*Non–resident

Specific objectives are,

i) to generate knowledge on the resource base, its distribution, spatial variations in quantity and quality, its growth or augmentation and degradation as they affect the future use, efficiency and productivity in irrigation systems.

ii) to describe use patterns and deepen understanding of interactions between the resource base and the resources users in respect of management practices, technology adoption and institutions through a participatory approach in order to predict future.

iii) to assess comparative status among systems in respect of potentials and constraints, and effects and impact of changes adopted in comparable situations by analysing outcomes of interventions under varying conditions using information from different sources.

iv) to identify potentials for spatial expansion and diffusion of models with promising adoptability in the irrigated agricultural sector.

v) to facilitate further collaborative research and catalize processes with local agencies by making information so generated available at appropriate levels.

Mandate

In the efforts of achieving these objectives, IIMI's mandate is,

(a) to facilitate addressing pressing problems in the irrigated agricultural sector with the collaborators,

(b) to ensure the participation of the stakeholders in the process of data generation, analysis and decision making, and

(c) to disseminate and share information locally and globally to increase knowledge as well as influence the relevant processes of change.

Users

IIMI's two fold approach in institutional strengthening by securing influencing presence in governmental committees and other bodies through participation as members as well as providers of technical guidelines for planning and helping the implementation of effective processes of desired change (Wijayaratna 1994:22) indicates the wide range of users of the spatial information produced. The participatory action research methodology adopted requires the active participation of the resources users, government and non-government functionaries, including provincial and national level policy making authorities. Shared Control of Natural Resources project (SCOR) of IIMI, Sri Lanka provides ample evidence to illustrate how multiple users at resources users level, and divisional, provincial and national level participate, in generating, utilizing for dynamic programming and periodic reviewing of the spatial information generated in the process (Batuwitage 1994:6).

Since IIMI's approach is to engage in collaborative research with government and non government agencies,including research institutions in the countries where it operates and to disseminate and transfer information and information systems produced to local agencies for continued use, the number and variety of users of such information are ever increasing. The demand for information sharing will increase with the increased networking that is being planned.

Documented outputs

In analysing a major local problem in the irrigated agricultural sector, SCOR project of IIMI in Sri Lanka views the problem in the background of the global setting. Annex 1 indicates the stagnating and then declining position of Sri Lanka among other countries in the Asia Region in average rice yields as reviewed from FAO year books (Wijayaratna 1994). Although the rice importation is found to be profitable financially than trying to grow it locally in Burkina Faso (Sally 1994:84) the search for explantation found that rice production in country is profitable than imports in Sri Lanka (Wijayaratna 1994:20) It is necessary to know the spatial aspects of rice yields and identify what causes the law yields and what management practices or yield increasing technologies could improve the yields where and how?

In a much broader perspective SCOR project examines how sustainable productivity of land and water resources can be brought about in watersheds adopting a systems approach taking into consideration the relationships of all the sub–systems of command drainage and the catchment. Such a perspective delineates a particular geographic space within which interactions and interventions take place. In order to effect change, knowledge has to be gained from the resource base and resource use in this landscape. Its terrain, drainage, land cover, land use, water resource input from rainfall, river/stream inflows and ground water, and factors affecting its availability including temperature, evaporation, run off, soils, vegetation, bio diversity, and production output with related socio–economic conditions of the people are important categories of information that has to be extracted from spatial and attribute data bases.

Annex 2 and 3 present this conceptualization of a typical landscape in two pilot watersheds in the dry zone and wet zone of Sri Lanka indicating the need for learning and mapping of each segment of the landscape that affects the productivity and efficiency of use patterns and the livelihoods of the users differently. The spatial relationship of the sub–systems of this landscape is important in determining institutional arrangements and technology use in the social and physical landscape.

Mapping of the past, present and the future (in 5 to 10 years time) of the landscape of the sub–watersheds to facilitate constraint analyses, action planning, participatory monitoring and self assessment is a unique feature of SCOR catalysing process. Annex 4 shows the direction of initial data collection and annex 5 presents a set of indicators to monitor and evaluate the change effected. Annex 6 provides a sample of data matrix that guides the cost effective data collection process and multi–disciplinary research of SCOR project.

Documented outputs during the past 17 months of SCOR operations in two pilot watersheds are available in 4 quarterly progress reports and papers presented at seminars local and abroad. Two sets of examples for both watersheds are presented here for sharing information.

Annex 7 shows the location of the two pilot watersheds. Annex 8 presents the 11 sub-locations in the 60 mile long stretch of landscape in the dry zone watershed. Annex 9 is the map produced by the resources users of the sub-location number 5 as output of the participatory resources use survey with SCOR members and government officials. Annex 10 is the output of SCOR GIS mapped to scale showing land use categories of the sub-watershed in details. Annex 11 is the output using the areal photographs of the sub-watershed to map the hydrological relationship within the cascade showing all the drainage lines to the two reservoirs and the production areas in the micro watersheds with area computations.

The information these maps carry on patterns of land use were the subject matter in the participatory constraint analyses that resulted in the mapping of the possible desirable future land use for the sub-watershed as presented in annex 12. This map identifies micro production sub regions for paddy, highland farming and homestead gardening. The technology adopted in the highland was conservation farming and integrated water management with seed/fertilizer technology was practices collectively in the paddy areas. The SCOR GIS produced copies of the two maps of current status and the future vision with titles and legends in local language for each of the resources user family who owns and uses them for their own monitoring. Annex 13 and 14 records the change being monitored and are self explanatory of the change recorded. The map for April was being prepared and records a yield increase from 30 – 35 bushels of rice per acre in the past from only half the command cropped to an average yield of 85 bushels per acre measured by a crop cut survey.

In the wet zone watershed where the terrain is hilly the landscape offered different set of problems and opportunities. The maps available at 1:10,000 scale by the Survey General department half been produced in 1989. Using those maps SCOR GIS produced slope maps and land cover maps as shown in annex 15 and 16. A three dimensional (orthographic) view was presented to highlight the factors of land degradation, soil erosion and effects that can be imagined from the effects of deforestation and the resultant land degradation on the downstream irrigated agriculture.

Annex 17 presents the gravity of the land use change in the slopes greater than 45%. An indicative land use for guidance is presented in annex 18. Annex 19 is the output of super imposing the individual land plots image produced in the participatory resource use survey on the slope image to extract information on who occupy what plots in the stressed area. The map is linked to the data base (annex 20) so that a series of thematic maps could be produced showing various combinations of data highlighting different phenomena.

Annex 21, 22 and 23 present a similar set of maps showing the baseline, planned future and status of one event monitored in the path of performance of the resources users.

The unique feature of the use of spatial information in SCOR project is that the maps and the linked data bases are used for dynamic programming, planning for the future vision and periodic monitoring of the action plans in a participatory mode.

Output of spatial information in the Pakistan program is available in large number of thematic maps produced by its GIS unit. They provide spatial information on land use categories, soils, hydrology, spatial distribution of the salinity problem in irrigation systems, ground water availability, quality, and use over time, and many other spatial aspects of resource distribution in irrigation systems. GIS is used to develop the predictive capability of the salinity conditions over large areas and evaluate a variety of salinity management alternatives(Strosser et.al.1994:4.18). The data bases offer great opportunities for undertaking many GIS operations that could generate new information to increase knowledge on the physical resource base and various relevant processes of resource use in those systems. Annex 24, 25 and 26 present soil map with detailed soil categories, ground water table depths and tube well density, few examples of the outputs of the Pakistan GIS unit.

IIMI operations in Burkina Faso conducted two studies to assess the extent of informal irrigation and environmental degradation around two of their study schemes using remote sensing techniques. The two studies have helped assess the possibilities and limitations of employing remote sensing techniques to monitor hydrological and ecological parameters related to the management of land and water in and around small scale reservoir based irrigation systems (Sally 1994:84).

2.2 Data and Information management capacities

Budget

The amounts of funds available for managing spatial data bases depend on the funds allocated for each individual research project. Also several other factors influence allocations such as,

a) the relative importance of spatial data use for the project
b) availability of technology to process, analyze, display and report of spatial data
c) availability of staff to undertake spatial data management
d) perceived cost of operations and,
e) awareness of possibilities in the use of GIS appropriately putting mission first and machine next to support.

The current thrust is to a cost effective design of data collection for a set of agreed upon indicators that can be used in several different research work. By this way duplication of data collection and mapping can be avoided and pooling of funds for spatial data base management could be attempted.

Staff

Currently IIMI has GIS units in field offices in Sri Lanka and Pakistan. IIMI headquarters plans to strengthen its GIS unit with staff,training and equipment.

Individual projects, employ staff for GIS work as required. In SCOR project of Sri Lanka programme, the M&E specialist handles GIS work with one assistant and three other supporting staff members whose main responsibility is not GIS work. SCOR gets map digitizing work from the Regional Development Study Centre of the Geography Department of Colombo University. All the other GIS functions including analysis, display and reporting are done by SCOR as indicated in the annexes 2 to 23.

Technology

SCOR project uses ArcINFO for map digitizing and IDRISI, a grid based Geographic analysis system developed by Clark University, U.S.A. for data processing and analysis. SCOR uses Delux Paint program for map display, map surface editing, updating and hard copy production. Colour printers and ordinary dot matrix printers are used to produce hard copies in a cost effective way.

SCOR GIS unit has scanning facility and software to produce artwork for printing of news letters, brochures etc.

In case satellite data are made available, SCOR IDRISI software can be used in data analysis and information extraction depending on the appropriateness of the particular application.

Pakistan and IIMI Headquarters use MapINFO software for output production. They undertake map digitizing as a data entry tool.

One observation is that GIS activities are limited to performing only certain functions to produce output that meet the minimum requirement of the work in hand due to the available skills, technology and access to data. Most common activities are the digital transformation of map data and producing map output for analysing and display. There is scope for increased use of analytical skills if links to databases and digital data sharing are facilitated.

Data

The most commonly used data in the research projects to extract spatial information falls within the following categories in irrigation systems or watersheds.

1. Land use, land cover, vegetation categories.
2. Elevation; terrain, slopes, aspect.
3. Climate including rainfall, temperature, evaporation, dry months.
4. Surface drainage, including rivers,streams,irrigation canals and other water bodies.
5. Ground water; rechargeability, quality.
6. Soils; type, depth, salinity, alkalinity.
7. Location of cascades and hydrological relationship.
8. Boundaries of plots,fields, tracts, systems.
9. Locations of structures, measuring points.
10. Location specific attributes such as crops, yields, occupants, inputs, outputs, growth rates etc. of spatial units of analysis of the particular research.

Location under item 10 above could be major irrigation systems or countries where data on global trends are required. Also, the location could be a paddy tract or a micro watershed for which data are collected at such a micro scale to capture change and record causes/conditions to change.

Data are collected in different frequencies. The GIS unit of IIMI– Pakistan mapped well density over a period from 1961 to 1992. SCOR project collects agro–well data on a sample of 30 wells out of 700 daily. Data are generated to assess the quantity, spatial and temporal availability and variability of the three kinds, i.e. rainfall, surface water and ground water(Fernando 1994:7.3). Annex provides a set of indicators and variables and the type and variety of data collected for SCOR research.

Networking

IIMI has at present a global network on Farmer–Managed Irrigation Systems, an Asian regional network on Irrigation Management for Crop Diversification, and a regional network in West Africa. IIMI is connected to CGNET II, AGRICOLA, AGRIS, AQUALINE, CABI, SESAME, SWRA, and TROPAG & RURAL are key international databases held on CD–ROM at IIMI's library.

IIMI hopes to disseminate research results obtained by IIMI and others through a world wide network focusing on key irrigation management topics. IIMI is also connected to Internet.

3. PRIORITY NEEDS

3.1 Data and information needs to achieve main objective

The objectives and the data and information needs are reflected under item 2.1 and 2.2 above and need no repetition. What is important is to determine the type, source, and mode of data availability from international databases at what cost and with what additional requirements of hardware and software acquisition to facilitate data transfer and with what additional staff, training for data processing and analysis.

Experience shows that if access to data and technology is available where basic skills of using them are present, staff can be motivated to use them and produce output that will generate more interest in the use of the technology since GIS produced spatial information are complementary to research production and presentation. There is a need to be informed of what is available with what cost so that one can form his/her view on the appropriateness of planning for using them.

3.2 Capacity building needs

Staff

Staff requirements for the three GIS units for the initial phase could be met if training is provided to those who handle GIS work at present by employing an experienced GIS analyst for 6 to 12 months depending on the need of each unit to use the available data and undertake applications for demonstration. It is possible to plan for additional staff assessing the future use of GIS at each unit depending upon the capabilities developed during the first 6 months.

There are many number of staff members in each location including the field offices and the headquarters who would like to gain abilities to use GIS in their research work.

Training

As it is indicated above, training is the means to achieve the desirable results of increased use of spatial data using GIS. According to priority, the training needs are as follows.

1. The use of GIS for extraction of information from spatial data with applications demonstrated.
2. Skill development to use a GIS system most appropriate to the need of the staff/organization, covering all the functions of the GIS including analytical capabilities and modelling, and working ability with all the peripheral equipment. The use of ArcINFO, mapINFO, and IDRISI are recommended since these software offer the most needed skills and capabilities to use GIS to extract

information from spatial data. IDRISI is recommended since it is versatile with the ability to create and maintain spatial databases and performing all the GIS functions relatively easily, handle satellite data, cheaper cost wise and easy to put in to use.

3. If remotely sensed data can be made available, training on image interpretation is needed. This can best be done by engaging staff to undertake an application relevant to the work already in hand. The problem of accessibility to spatial data in this regard has to be resolved. The appropriateness of using satellite data, in respect of resolution for the typical size of geographic locations, availability of cloud free scenes, and costs involved are other issues to examine.
4. Awareness of various sources of data that can be accessed through information networking, procedures and costs.
5. The data transfer and retrieval methods through information networking.

Technology

Although the use of GIS technology for spatial data processing and analysis is increasingly becoming popular, its appropriate use for many research work has not been adequately demonstrated through applications. One reason for this situation is the wrong choice of technology (Hardware and software) that alienates potential users from the use of GIS due to perceived difficulties in the ability to master the technology within a reasonably shorter period of time. The failure to provide continued support until adequate number of applications are done to be confident of the technology use has been a common problem.

The decisions on the choice of systems should be made after careful consideration of the requirements of the mission, the minimum capacity needed, the environment where the technology is to be used and the level of staff and their training needs.
Technology for data acquisition and transfer from various sources, data input and retrieval and processing demands the use of different equipment both hardware and software. Guidance is needed for making correct decisions in the choice of technology for the appropriate use.

3.3 Networking needs to facilitate exchange of data and information

Current networking needs in order of priority are as follows.

1. Full connectivity to Internet. The current facility is limited to e–mail only.
2. Low cost network platform. A PC based facility is needed.
3. Capacity of systems not only to facilitate electronic data transfer, but also the image display facility in using spatial data.
4. Skill development in data transfer, retrieval and exchange and system maintenance.
5. Information on international networks, and accessible databases.

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List of Annexes

Rice yield in Selected Countries of Asia and the Pacific

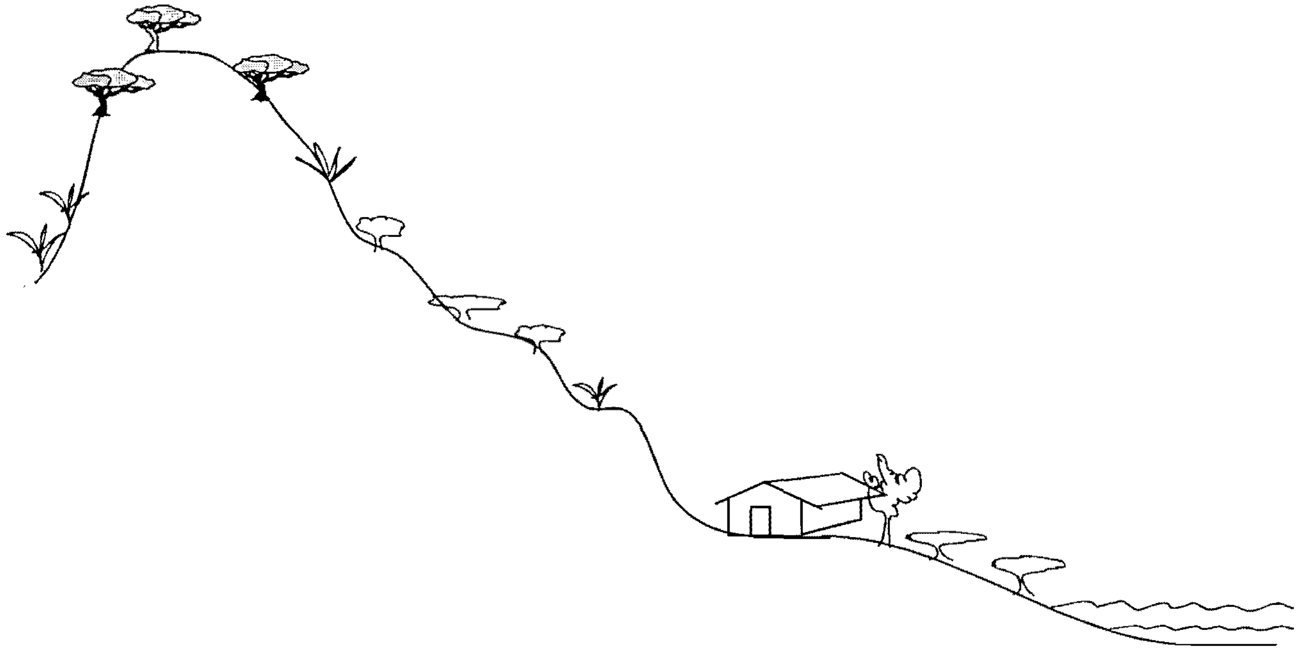
(Unit: KG/HA)

Asia	1985	1986	1987	1988	1989	1990	1991	1992
Afganistan	2,243	2,243	2,262	2,290	2,103	1,903	1,936	1,714
Bangladesh	2,170	2,178	2,377	2,355	2,624	2,566	2,659	2,705
Bhutan	2,109	2,086	2,284	1,657	1,654	1,654	1,654	1,654
China	5,253	5,328	5,413	5,281	5,500	5,716	5,636	5,807
Cambodia	1,200	1,176	1,000	1,333	1,389	1,539	1,645	1,222
DPR.Korea	6,905	6,977	7,086	8,060	8,209	7,910	7,879	8,333
India	2,329	2,224	1,999	2,549	2,635	2,628	2,619	2,607
Indonesia	3,942	3,977	3,919	4,111	4,247	4,302	4,346	4,488
Iran	3,698	3,738	3,765	3,051	3,665	3,779	4,112	4,167
Laos	2,087	2,259	2,436	1,912	2,355	2,337	2,197	2,535
Malaysia	2,977	2,930	2,930	2,678	2,696	2,990	2,732	2,818
Myanmar	n.a.	n.a.	n.a.	2,909	2,918	2,935	2,848	2,922
Nepal	2,016	2,101	1,779	2,264	2,366	2,407	2,283	2,259
Pakistan	2,350	2,532	2,531	2,351	2,293	2,315	2,320	2,507
Philippines	2,663	2,669	2,644	2,644	2,705	2,808	2,824	2,813
Rep. Korea	6,351	6,369	6,019	6,555	6,519	6,206	6,035	6,134
Sri Lanka	3,071	3,094	3,132	3,037	2,992	3,064	3,022	2,848
	*–(7)	*–(7)	*–(7)	*–(7)	*–(8)	*–(8)	*–(8)	*–(9)
Thailand	2,061	2,052	1,961	2,146	2,021	1,956	2,052	1,958
Vietnam	2,783	2,813	2,686	2,969	3,227	3,189	3,158	3,209
Japan	6,225	6,322	6,186	5,886	6,168	6,328	5,859	6,273
Paciific								
Australia	6,857	6,424	5,660	6,981	7,643	8,093	8,320	8,813
Fiji	2,366	2,427	2,276	2,399	2,421	2,981	2,279	2,357
Papua New Guinea	3,000	3,000	3,000	3,000	3,000	2,952	3,024	3,024

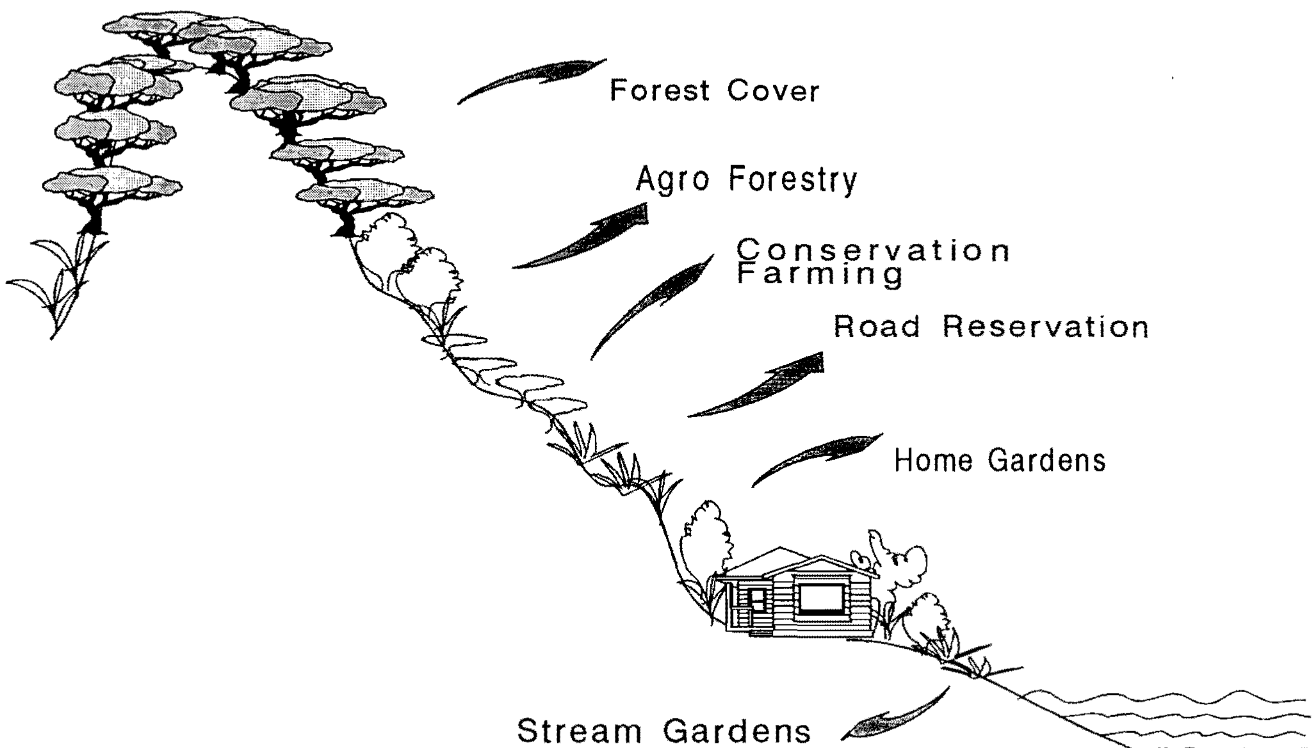
Source: FAO Production Yearbooks

Remarks:
n.a. – not available
*– position

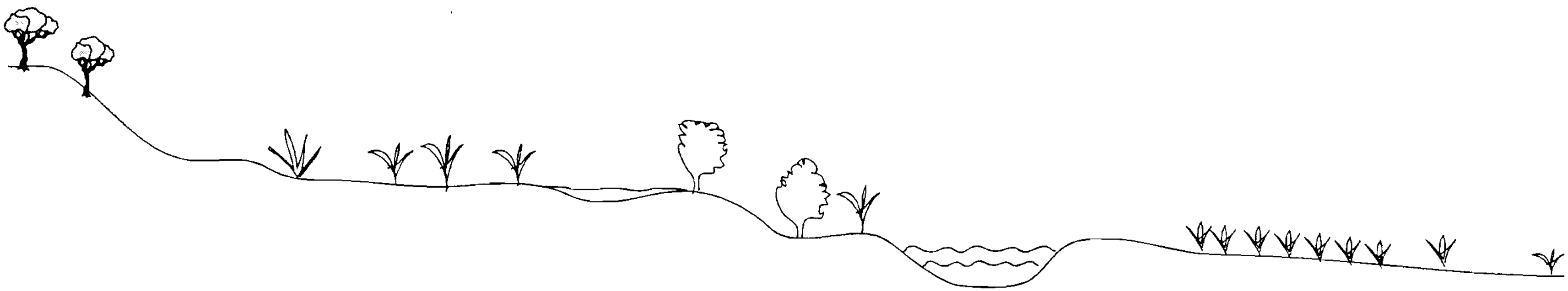
A Typical Landscape Profile Calling for Intervention in Upper Nilwala Watershed



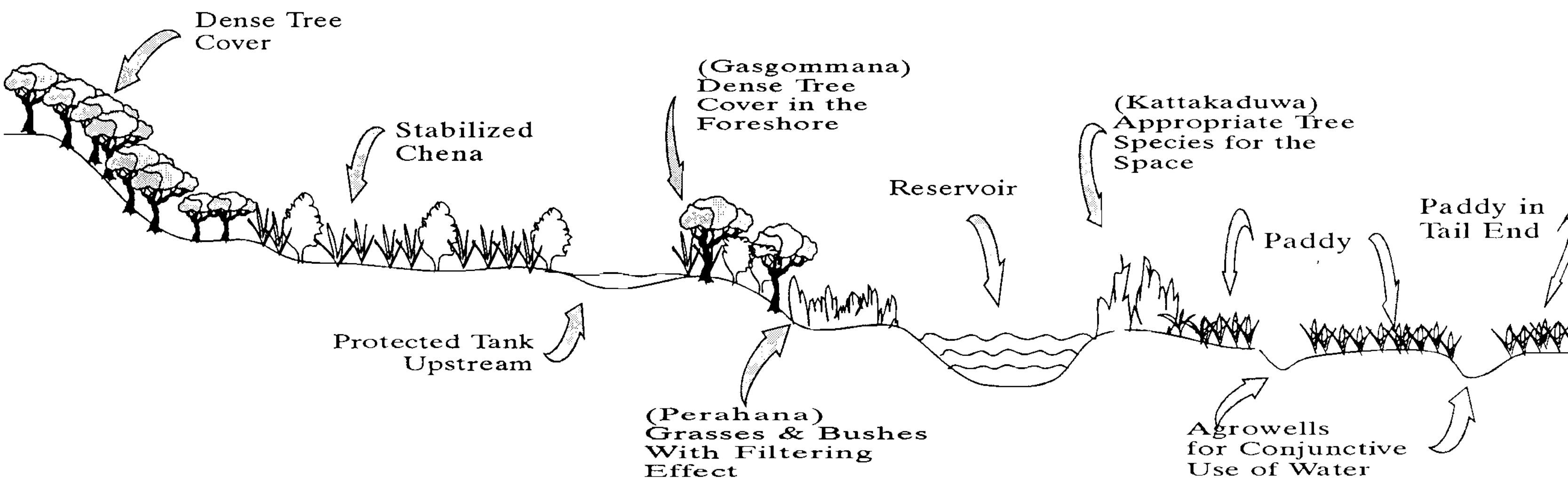
Anticipated Change in Landscape After SCOR Intervention



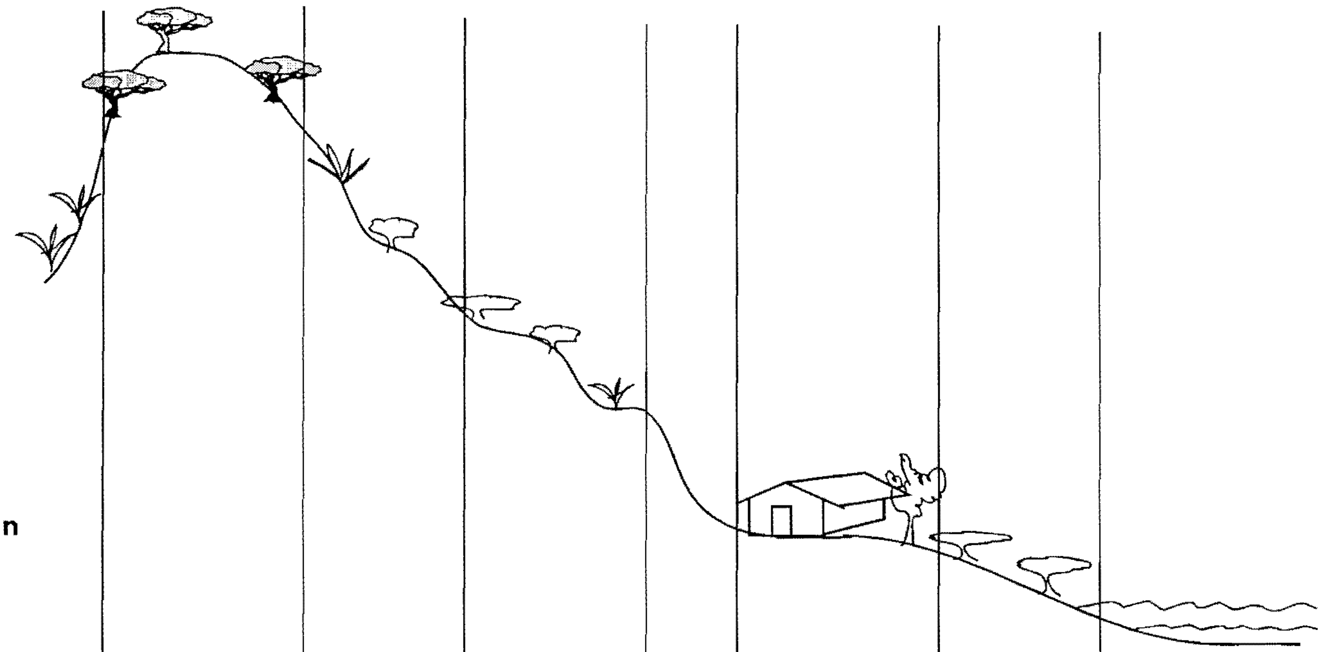
Current Typical Landscape in Huruluwewa Watershed



SCOR Perception of Future Landscape in Huruluwewa Watershed



Data Gathering for Model Sub-Watershed



Vegetation							
Soil							
Water							
Food Crops							
Cash Crops							
Forestry							
Socio-economic							
Condition							
Households							
Tenure							
Resource Management Practices							
Problems							
Opportunities							

INDICATORS FOR MONITORING AND EVALUATION
SCOR PROJECT

Number, Level of maturity, investments, turnover,
Survival ratio of capital works of user groups,
Organizations and councils

Awareness level
Commercial activities, User grants

Ground water potential

- Surface and Ground
- Water use efficiency
- Income Cost of production, profits

- Usufructuary rights
- Trees
- Land cover

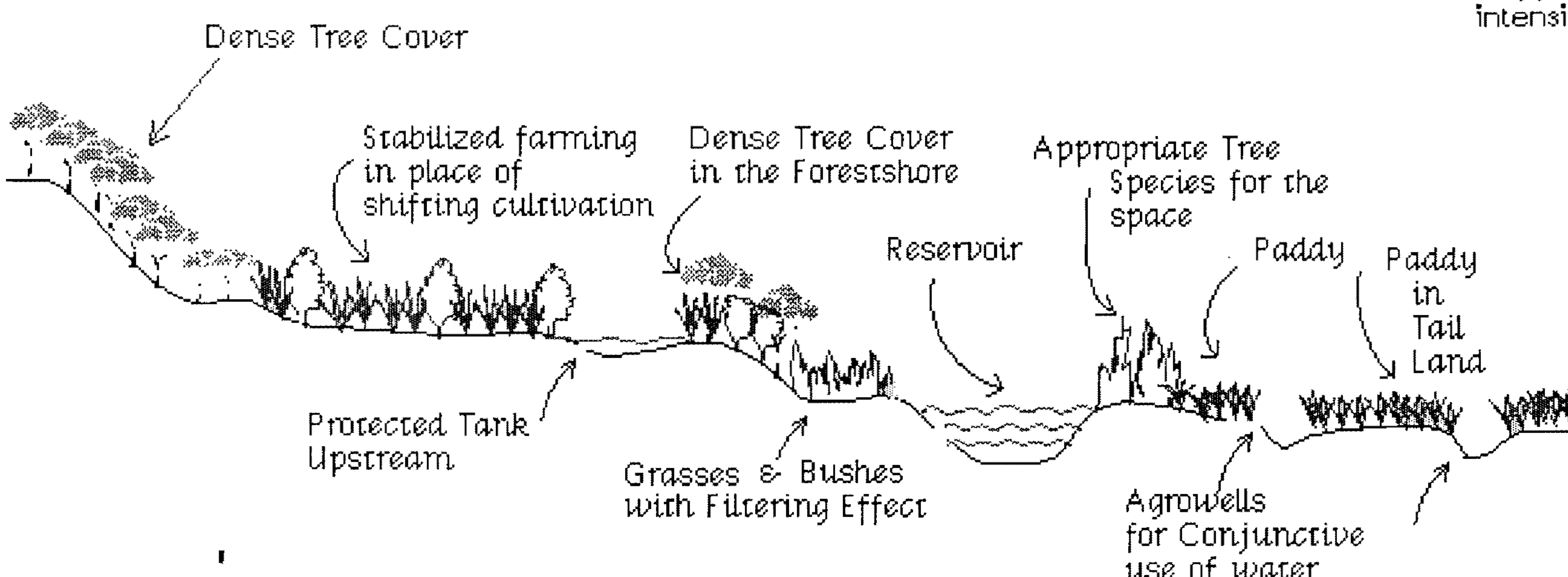
- Soil loss
- Infiltration
- Runoff

- Use rights
- Conservation practices

- Trees
- Land cover

- Tank storage
- Sedimentation
- Water quality

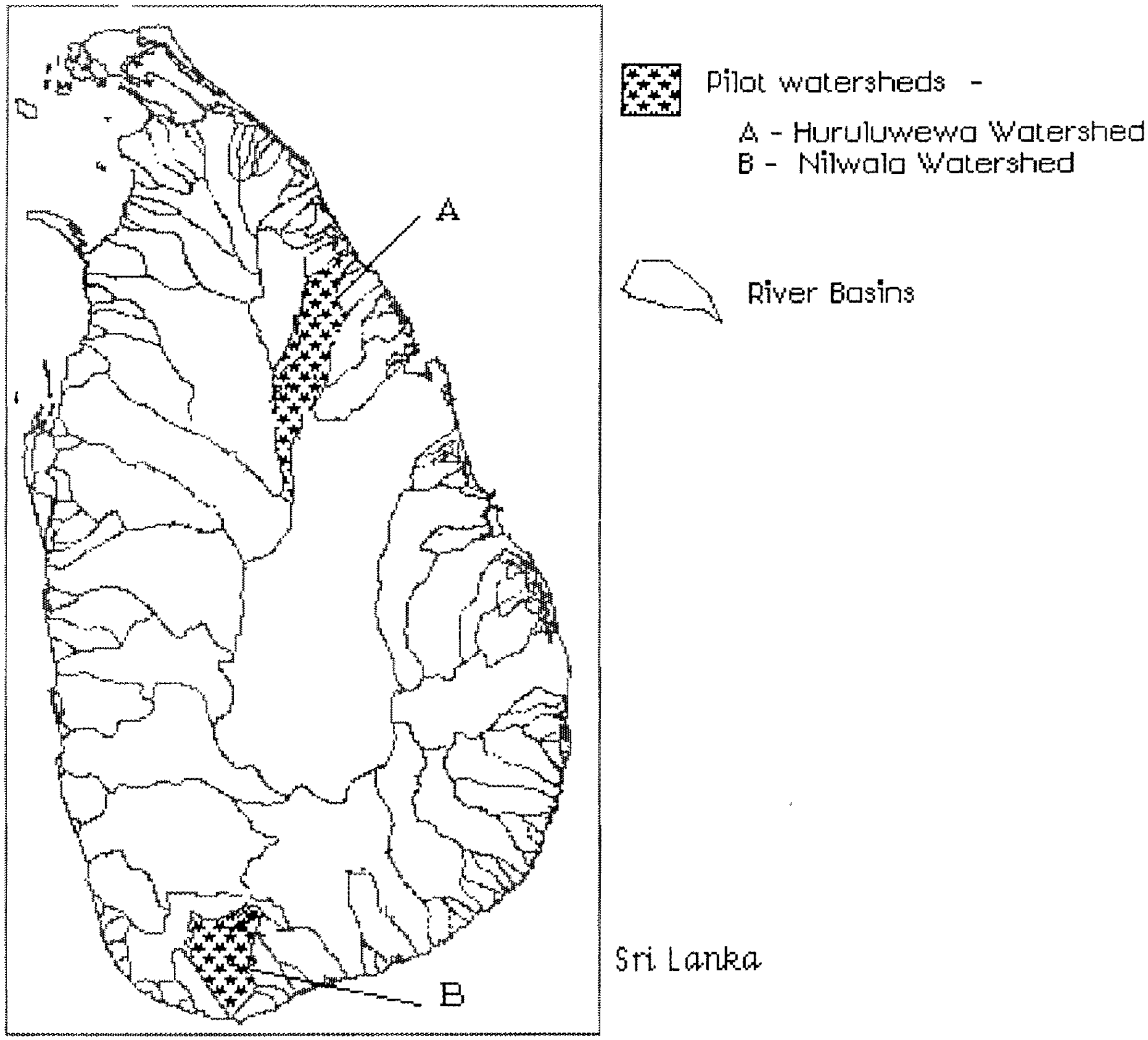
- Plants Value
- Yield
- Cropping intensity

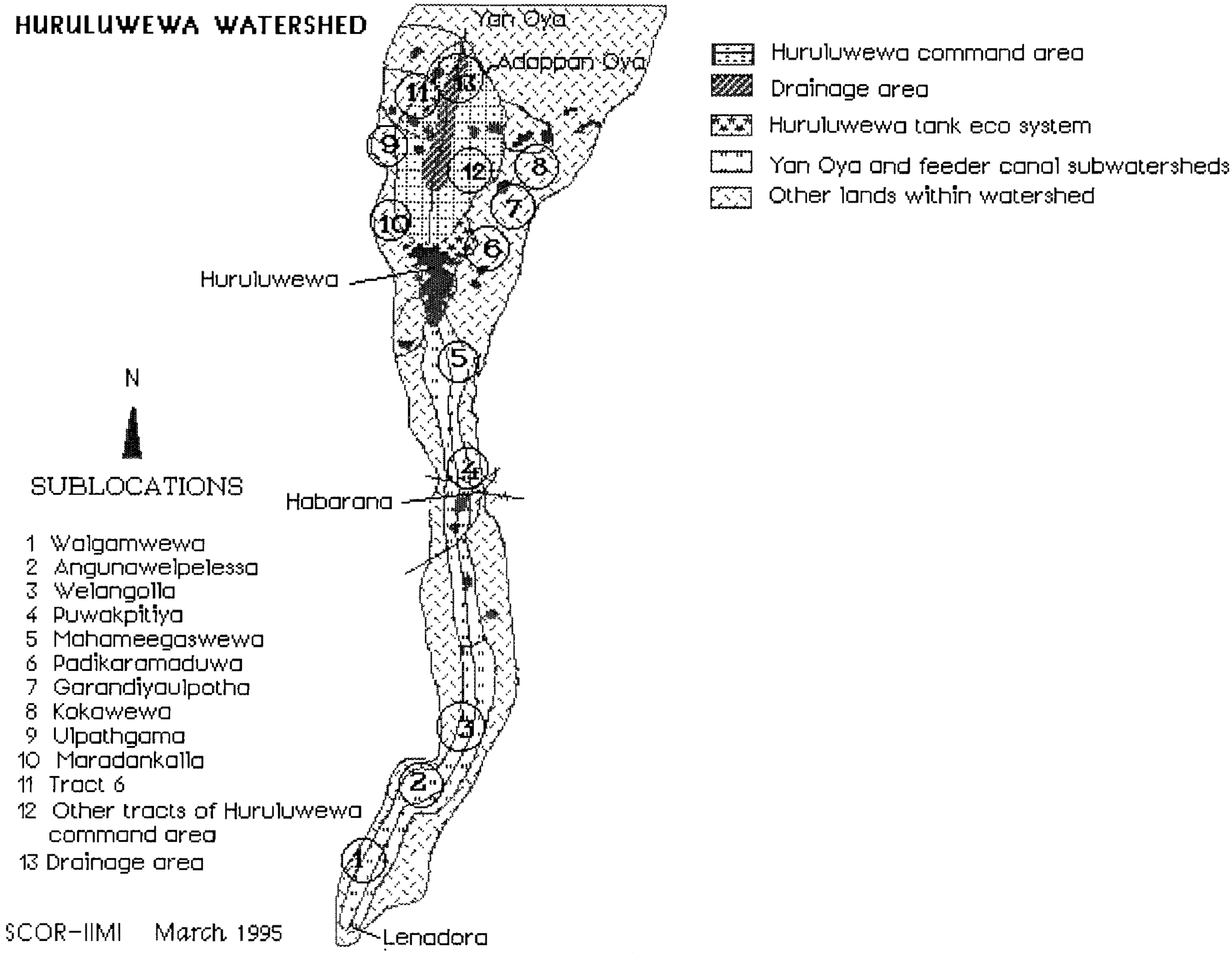


SCOR RESEARCH PROGRAM BASED ON ACTIVITY AREAS

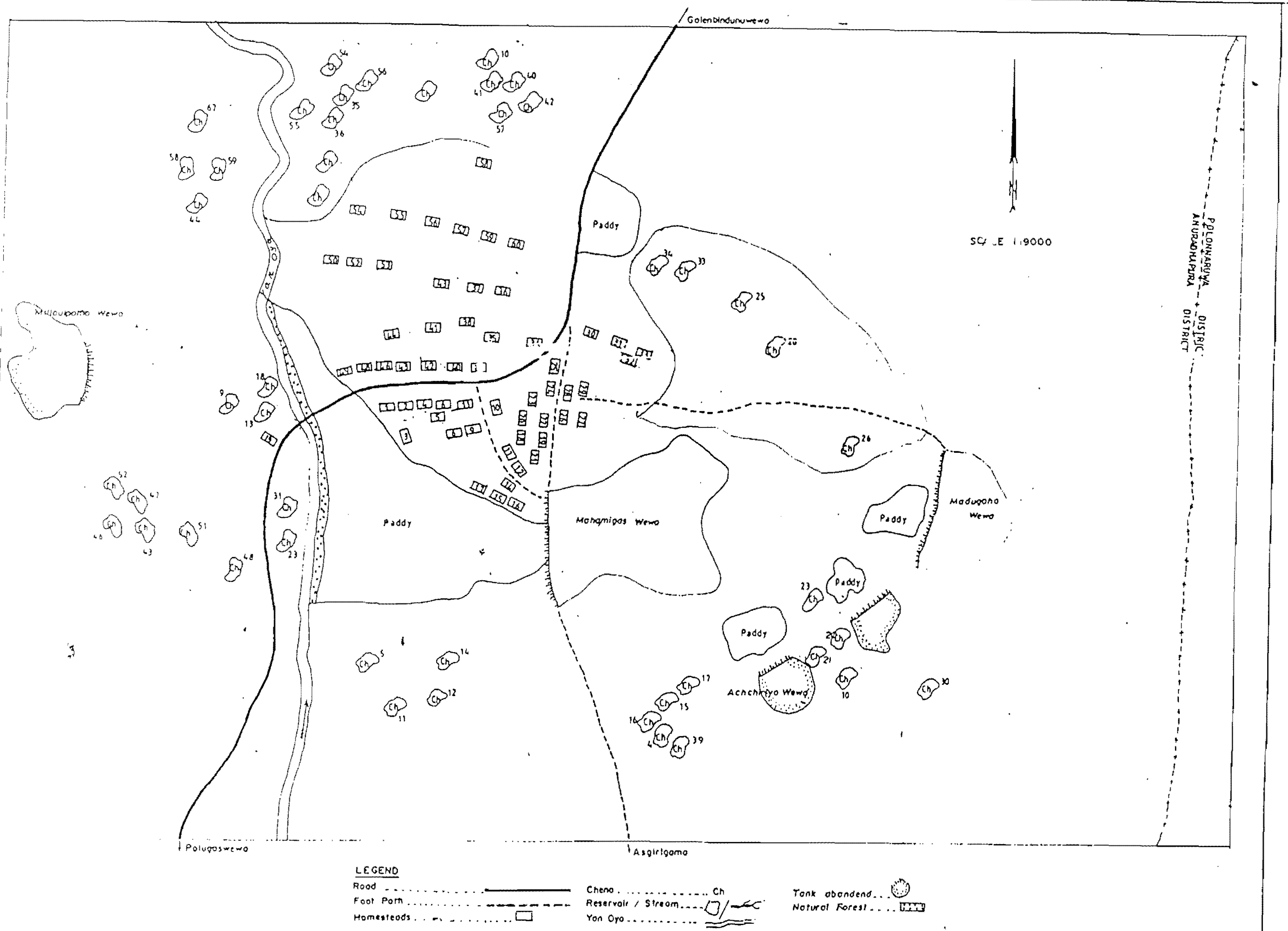
SUBJECT AREA/ DECIPLINE	INDICATOR/ VARIABLES	SAMPLE				RESPONSIBLE PERSON
		HURULUWEA		NILWALA		
		SIZE	LOCATIONS	SIZE	LOCATIONS	
Surface water balance	Water balance –Rainfall –Evaporation –Temperature(Max & Min) –Tank storage –Tank water release –Tank water level –Infiltration –Wind speed –Cloud cover –Ground water(well levels)		6 locations in mahameegaswewa 2 locations in mahameegaswewa 2 locations in mahameegaswewa Meegaswewa tank Meegaswewa tank Meegaswewa tank Meegaswewa Meegaswewa Meegaswewa Meegaswewa			BSB NF
Effecient use of water	Water Duty –Total water issues –Total area irrigted –Total area cultivated – Agro–wells –Total area harvested	Well Nos. 1–28	Dutuwewa, Palugollagama, Kokawewa, Dutuwewa, Getalawa, Janasirigama, Hurulu–Nikawa, Kieakada, Rathmalgama, Kalekumbukwewa, Maharabawewa, mahadivulwewa, Yakalla, Kudagalenbidunuwewa, –Huruluwewa command –Tract 6 –Puwakpitiya –Padikaramaduwa –Feeder canal			NF
	Relative Water Supply –Irrigation requirement (computed) –Total Water used –Rainfall –Evaporation –Percolation losses	Well Nos. 1–28 (as above)	same locations as water duty			NF
	Feeder canal inflow/outflow Ratio (water use in Feeder canal) –Inflow at canal inlet – Outflow at canal ends		Bowatenna outlet Kandalama bification Wewala Habarana confluence point			NF

SHARED CONTROL OF NATURAL RESOURCES (SCOR) WATERSHEDS

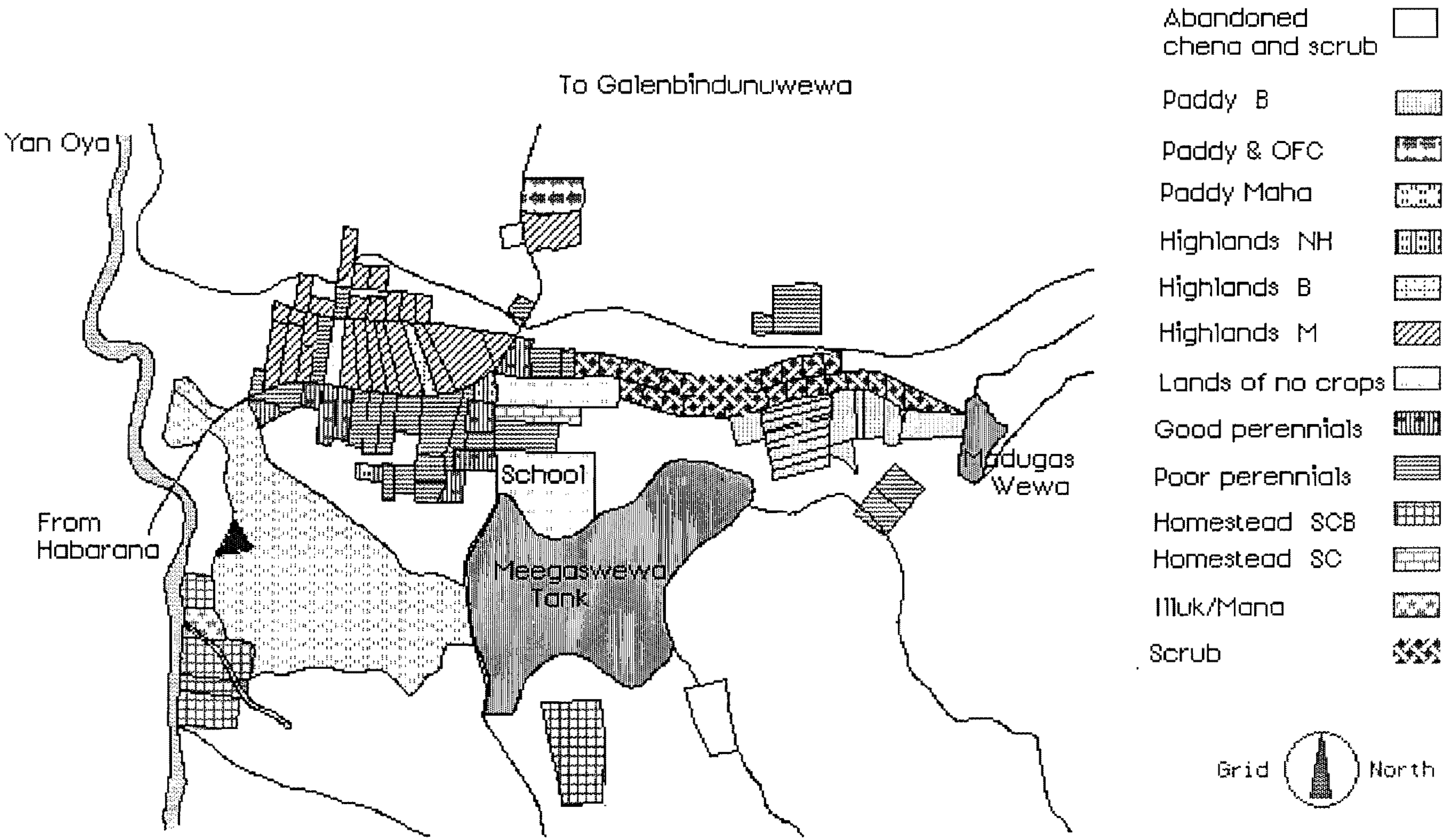



HURULUWEWA WATERSHED
Yan Oya
Adappan Oya
Huruluwewa
Habarana
Lenadora
N
Huruluwewa command area
Drainage area
Huruluwewa tank eco system
Yan Oya and feeder canal subwatersheds
Other lands within watershed
SUBLOCATIONS
1 Walgamwewa
2 Angunawelpelessa
3 Welangolla
4 Puwakpitiya
5 Mahameegaswewa
6 Padikaramaduwa
7 Garandiyaulpotha
8 Kokawewa
9 Ulpathgama
10 Maradankalla
11 Tract 6
12 Other tracts of Huruluwewa command area
13 Drainage area
SCOR-IIMI March 1995

Map of Mahameegaswewa Purana Village



MAHAMEEGASWEWA LAND USE - JANUARY 1994

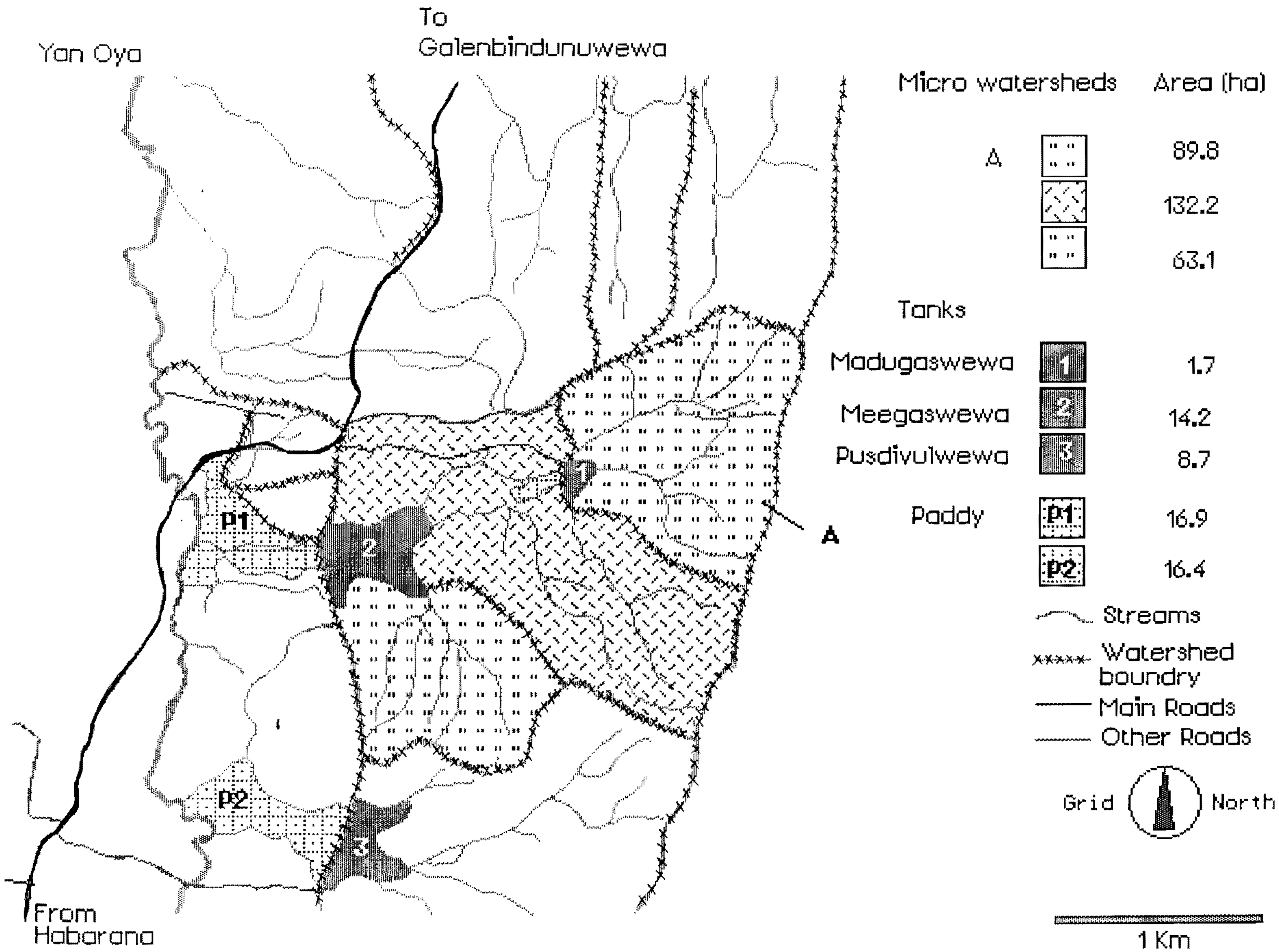


Huruluwewa watershed IIMI SCOR

Chena = Slash and burn cultivaiton
OFC = Other Field Crops
SCB = Seasonal Cropping Both seasons
SC = Seasonal Cropping one season

Idrisi

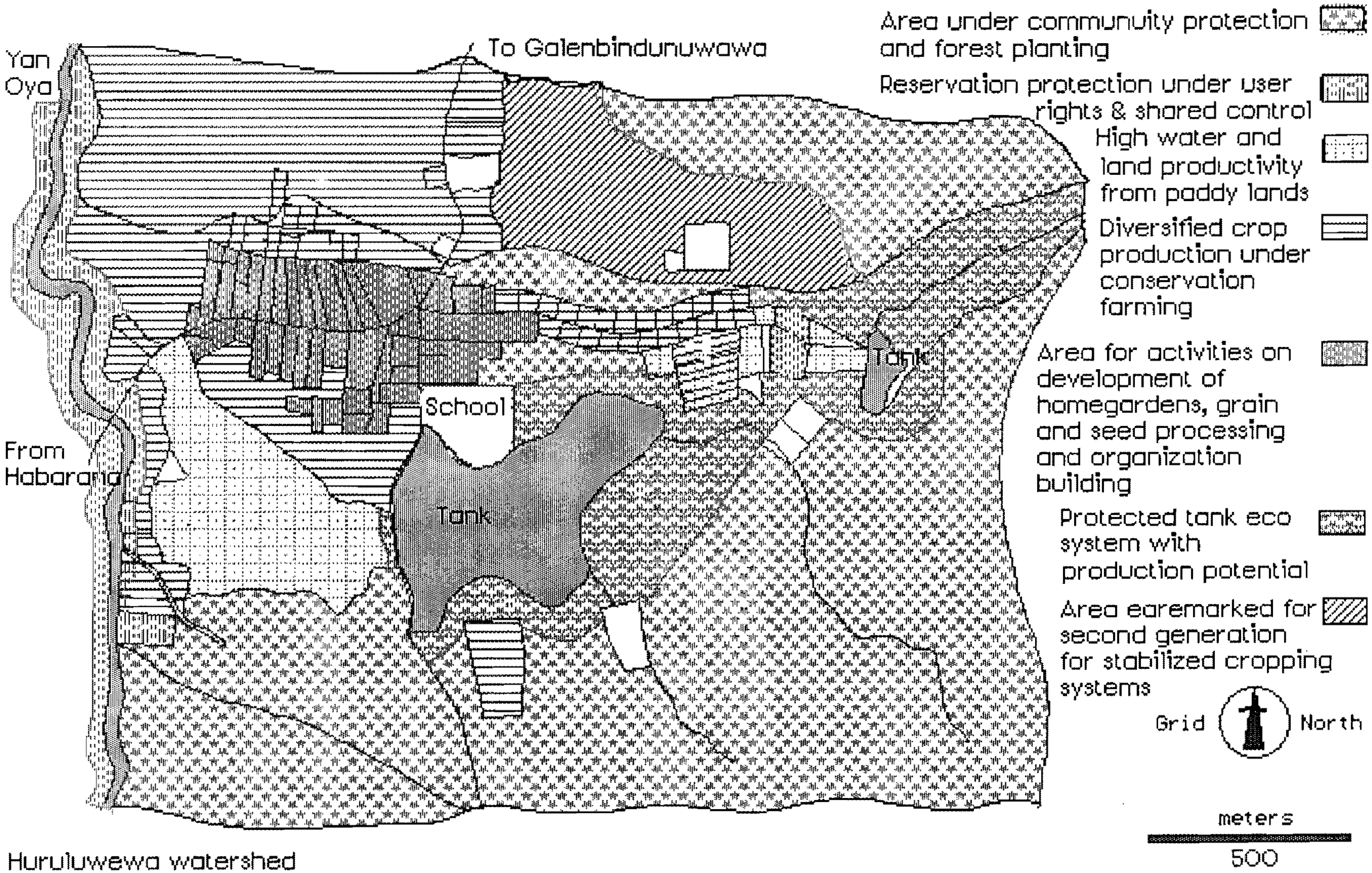
MAHA MEEGASWEWA MICRO WATERSHEDS



IIMI-SCOR March 1995 Mahameegaswewa Tank Catchment Area - 285 ha.

Idrisi

PLANNED FUTURE LANDUSE FOR MAHAMEEGASWEWA

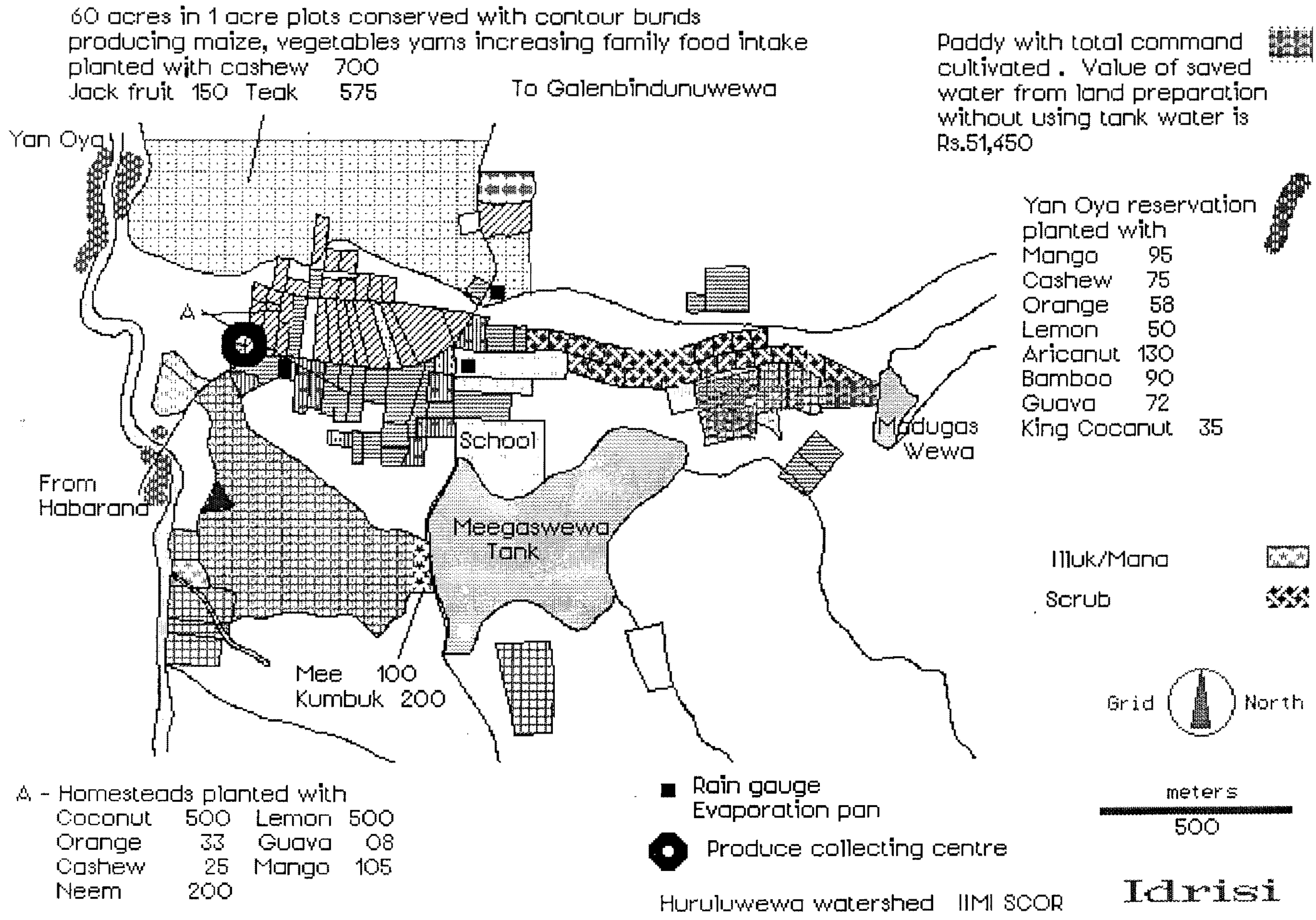


Huruluwewa watershed

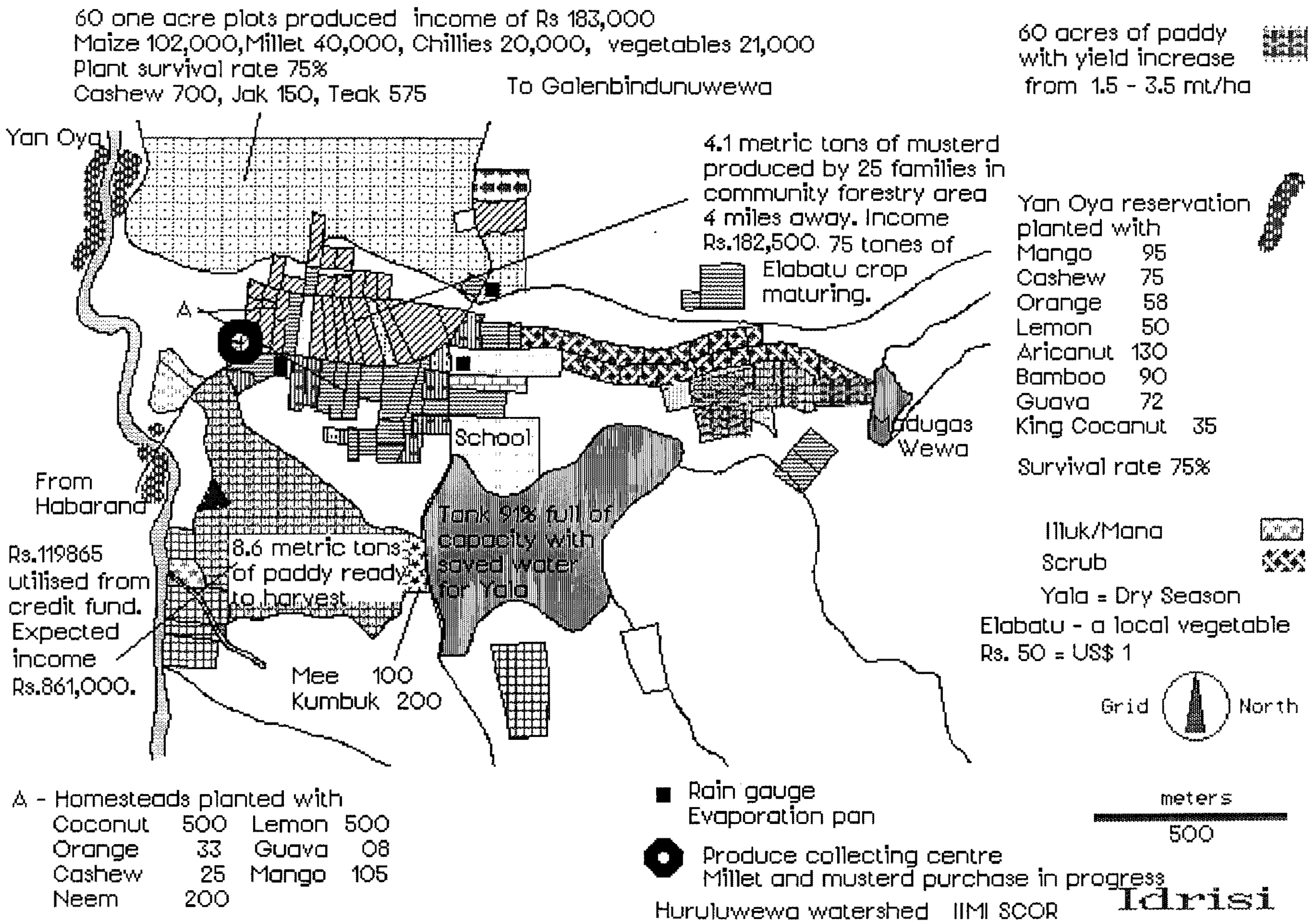
SCOR Project - IIMI August 1994

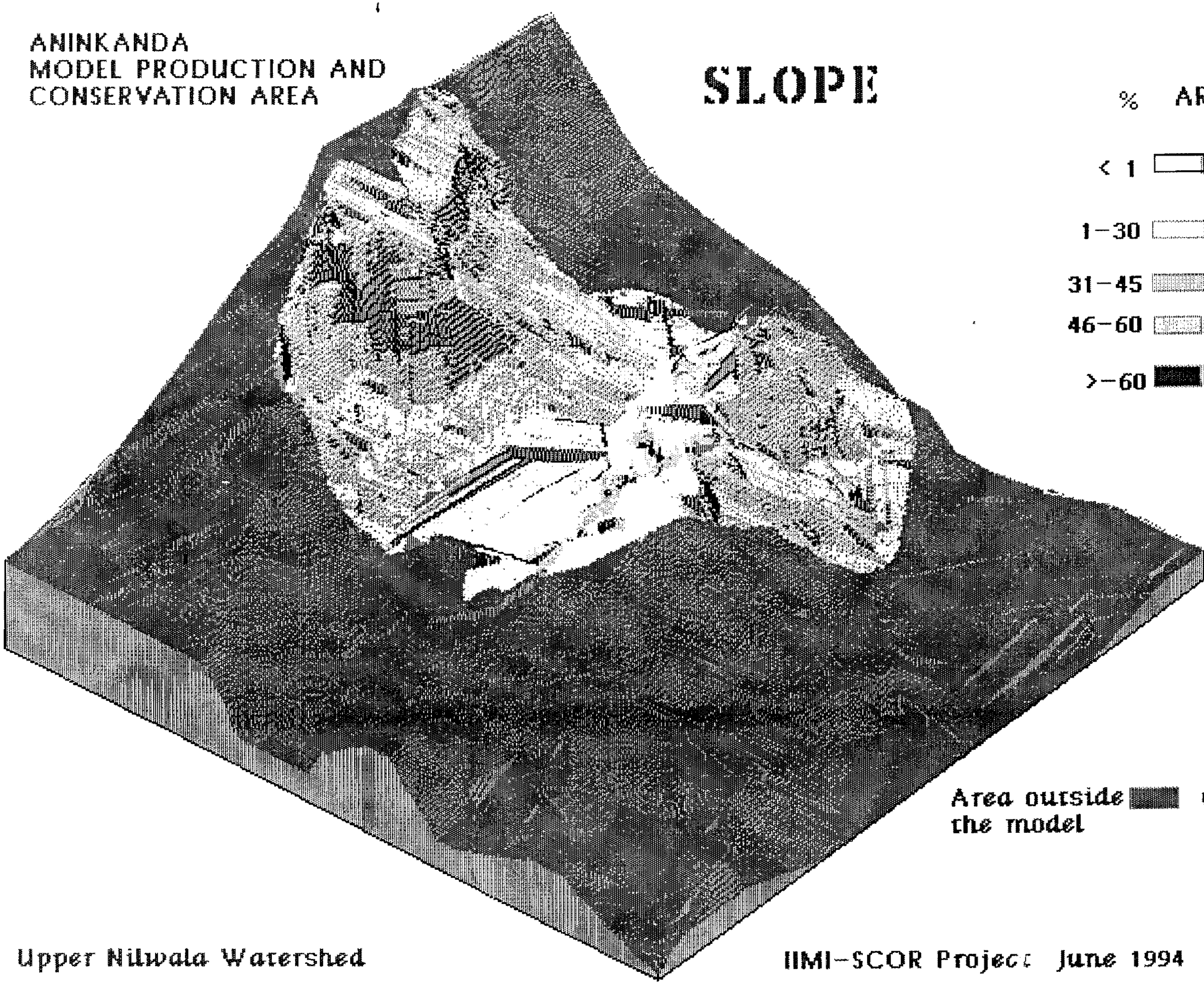
Idrisi

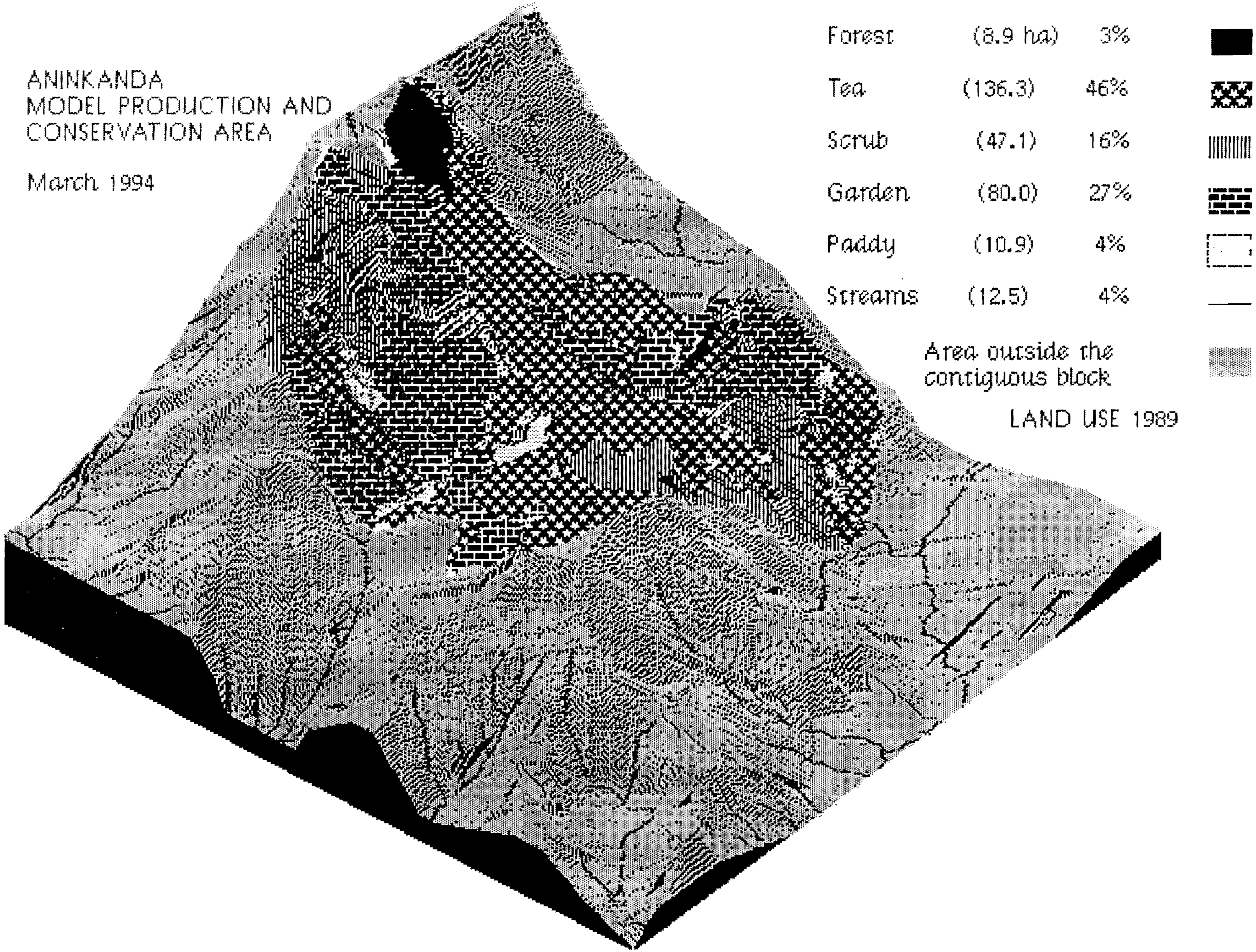
MAHAMEEGASWEWA LAND USE - December 1994



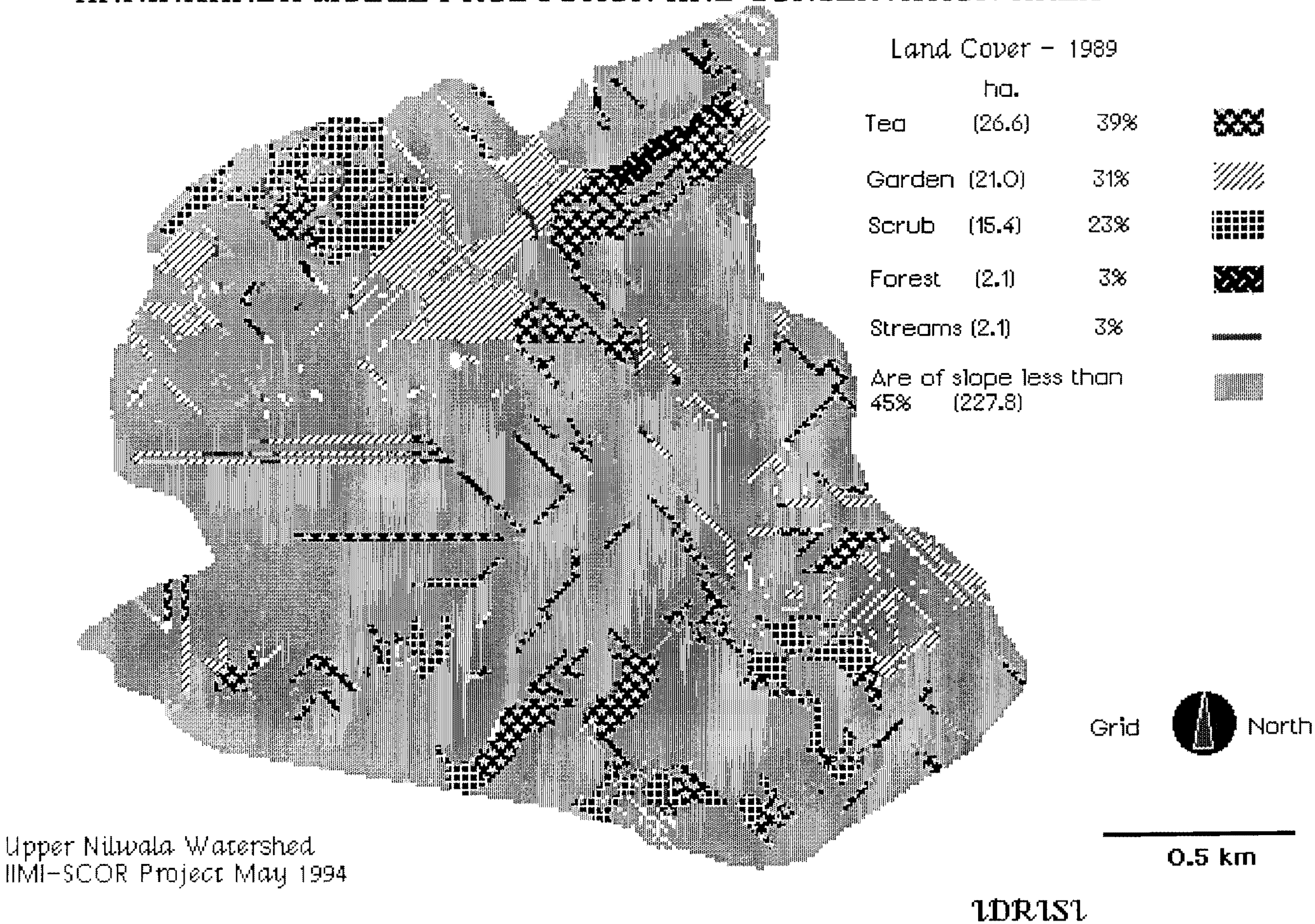
MAHAMEEGASWEWA LAND USE - FEBRUARY 1995




ANINKANDA
MODEL PRODUCTION AND
CONSERVATION AREA
SLOPE
% AREA(h)
< 1 27.6
1-30 126.8
31-45 71.5
46-60 36.2
>-60 33.7
Area outside the model 604.2
Upper Nilwala Watershed
IIMI-SCOR Project June 1994

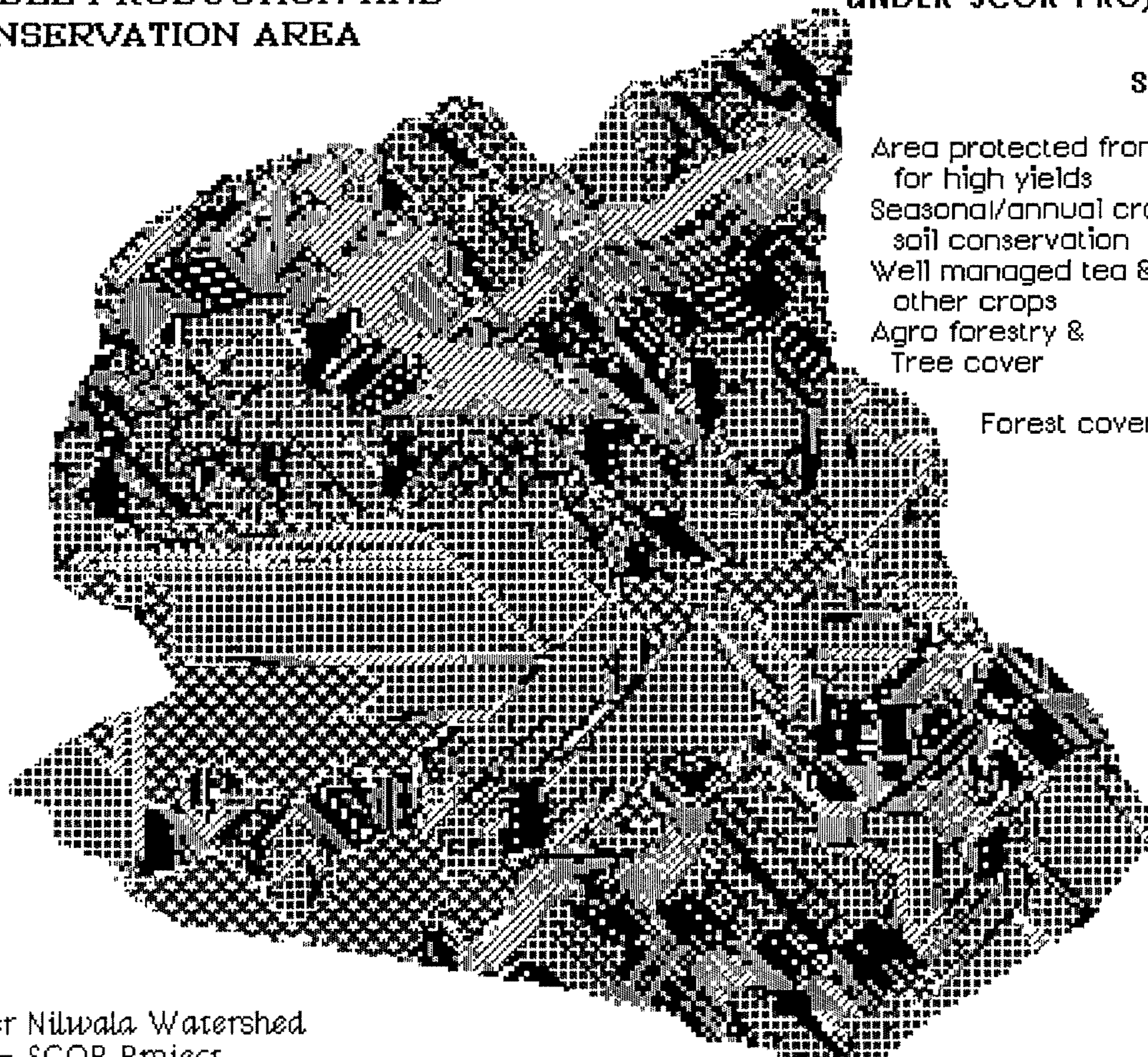

ANINKANDA
MODEL PRODUCTION AND
CONSERVATION AREA
March 1994
Forest (8.9 ha) 3%
Tea (136.3) 46%
Scrub (47.1) 16%
Garden (80.0) 27%
Paddy (10.9) 4%
Streams (12.5) 4%
Area outside the contiguous block
LAND USE 1989

AREA OF SLOPE GREATER THAN 45%
ANNINKANDA MODEL PRODUCTION AND CONSERVATION AREA



ANNINKANDA MODEL PRODUCTION AND CONSERVATION AREA

ANTICIPATED CHANGE IN LAND USE UNDER SCOR PROJECT



	Slope %		Area (h)
Area protected from silting for high yields	< 1		27.6
Seasonal/annual crops under soil conservation	1 - 30		126.8
Well managed tea & other crops	31 - 45		71.5
Agro forestry & Tree cover	46 - 60		36.2
Forest cover	> 60		33.7

Grid North

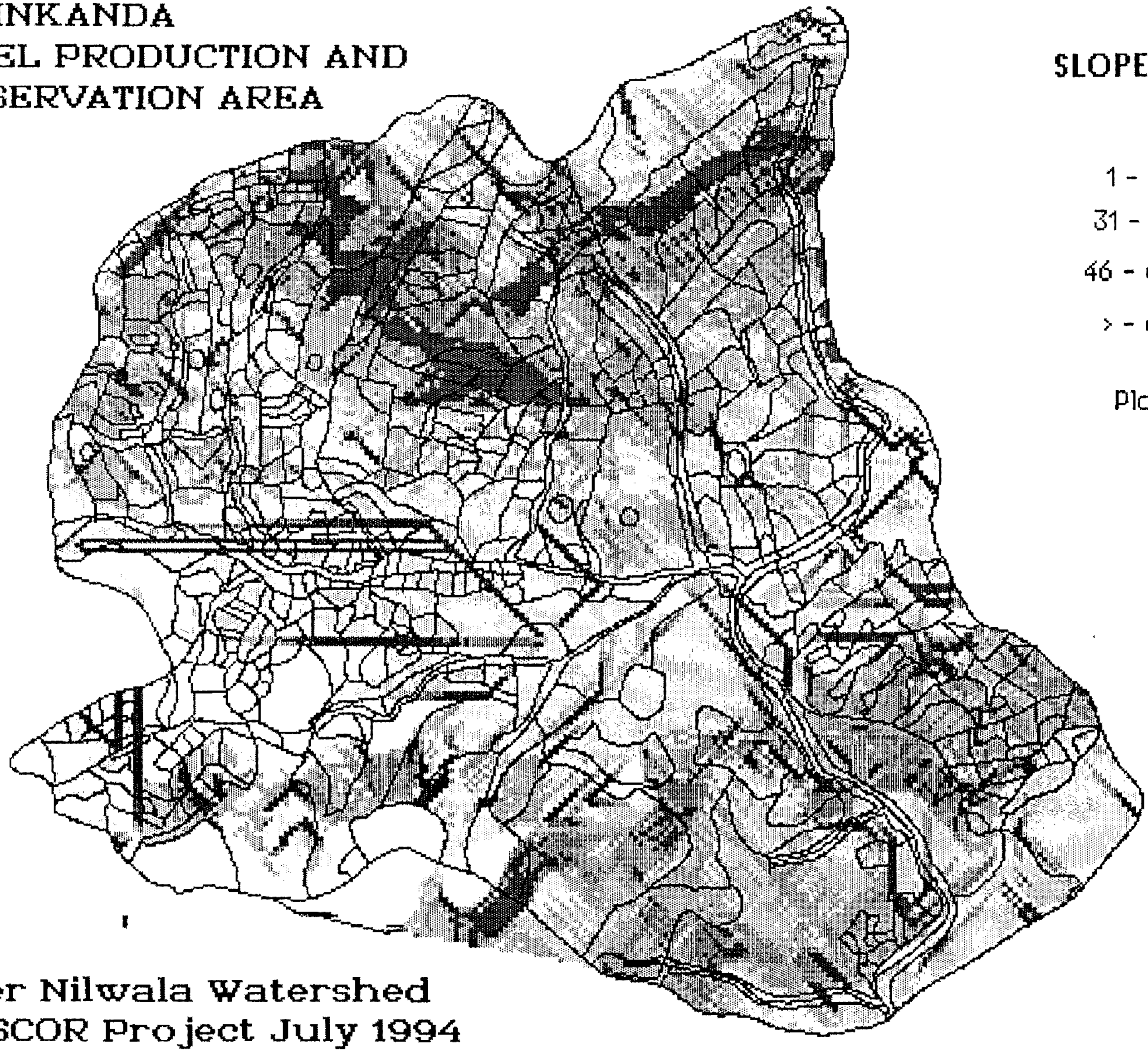
0.5 km

Upper Nilwala Watershed
IIMI – SCOR Project
July 1994

IDRISI

SLOPES AND PLOTS

ANNINKANDA
MODEL PRODUCTION AND
CONSERVATION AREA



SLOPE %		AREA(h)
< 1		27.6
1 - 30		126.8
31 - 45		71.5
46 - 60		36.2
> - 60		33.7
Plots		

Grid North

kilometers
0.5

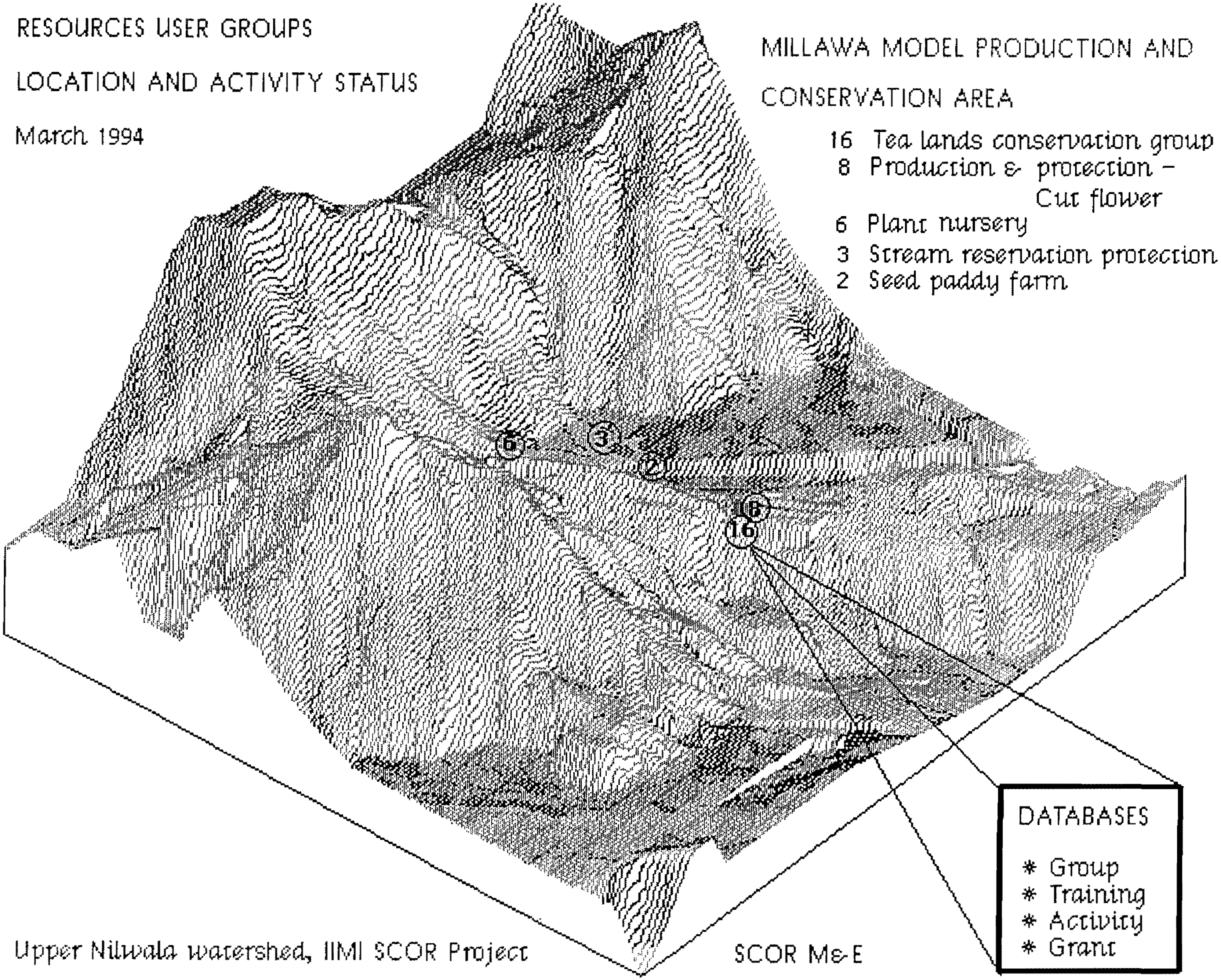
Idrisi

Upper Nilwala Watershed
IIMI-SCOR Project July 1994

RESOURCES USER GROUPS

LOCATION AND ACTIVITY STATUS

March 1994

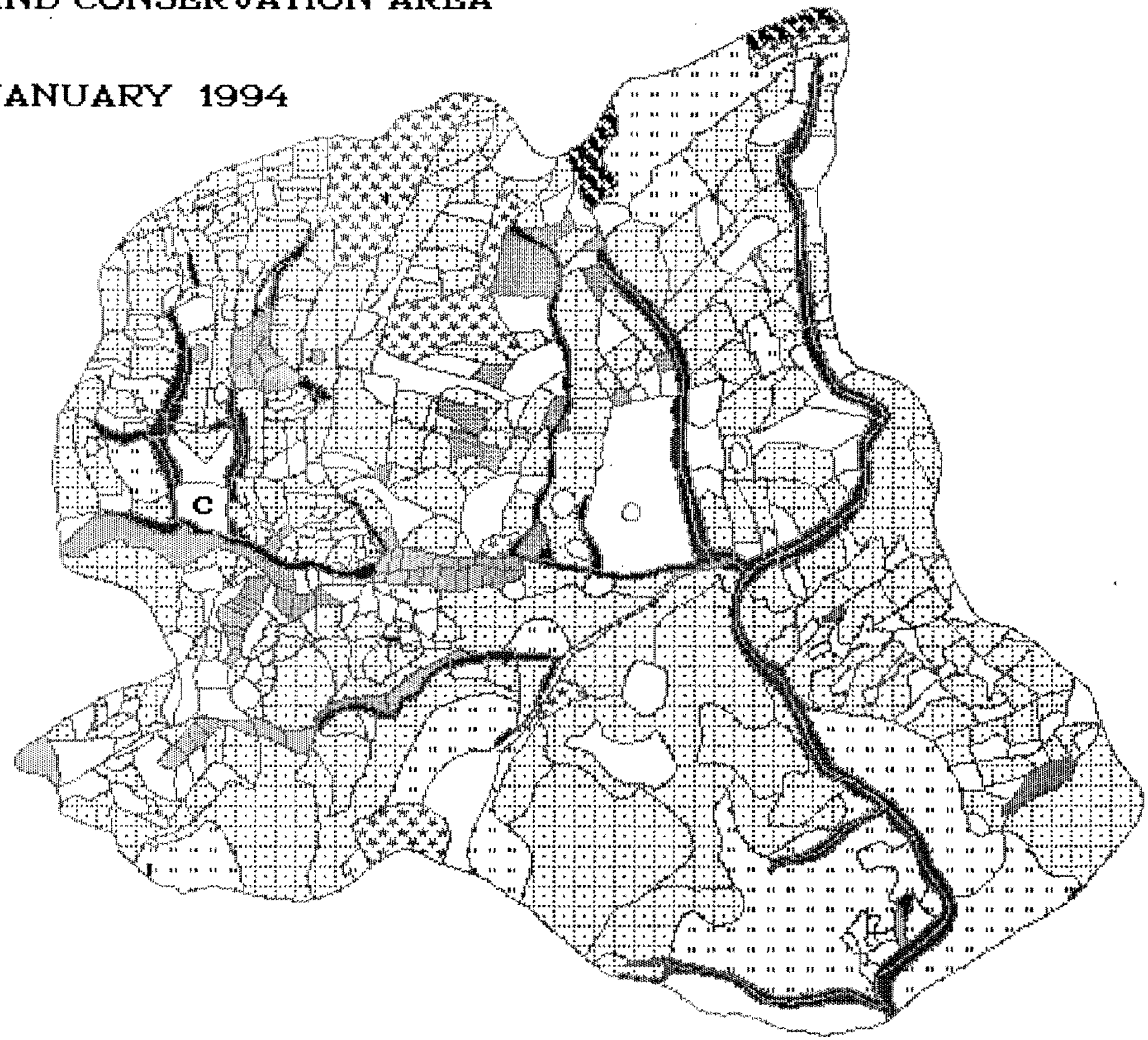


Upper Nilwala watershed, IIMI SCOR Project

SCOR M&E

LAND USE - ANINKANDA MODEL PRODUCTION AND CONSERVATION AREA

JANUARY 1994

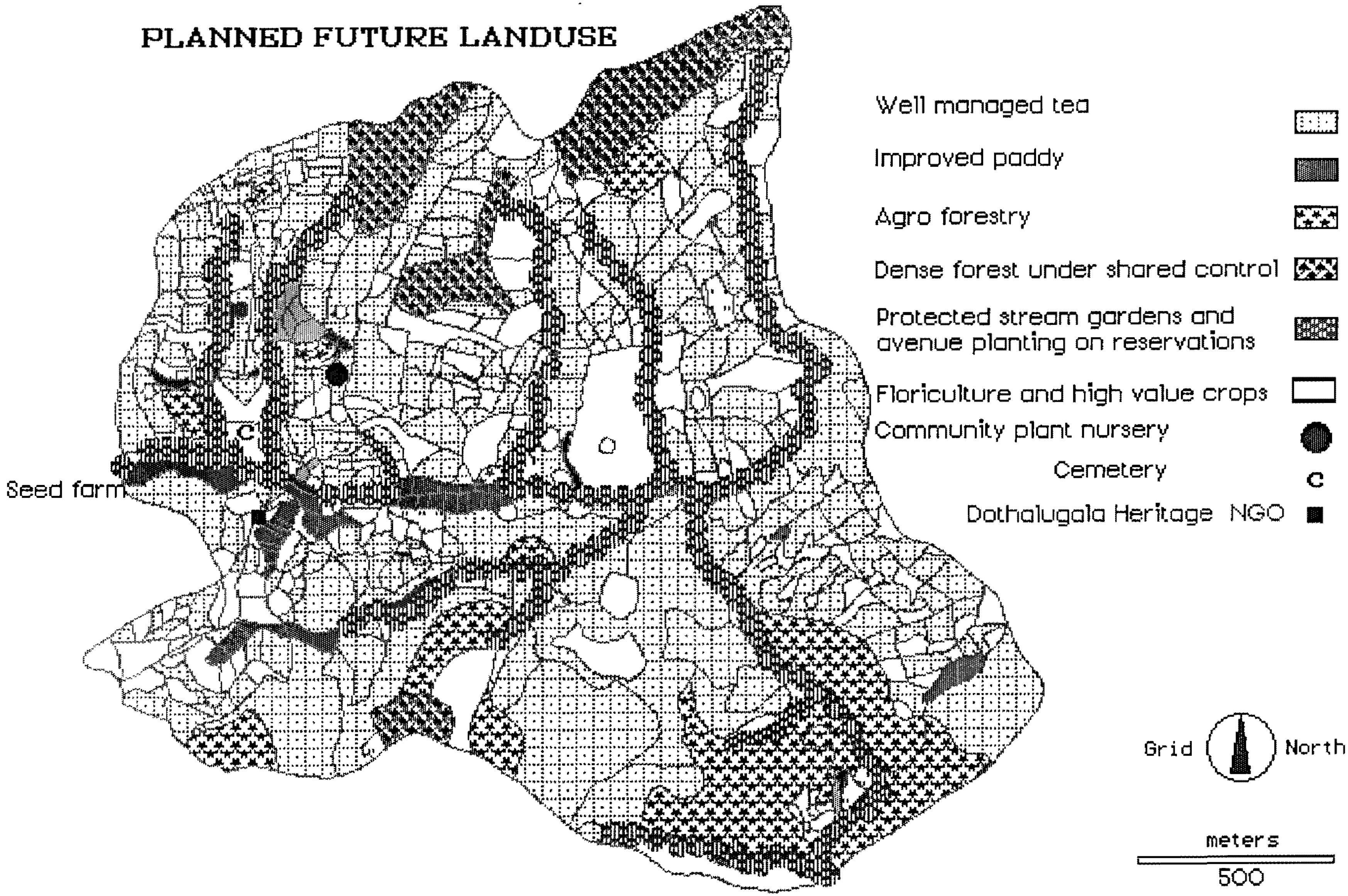


Upper Nilwala Watrshed SCOR IIMI

Idrisi

ANINKANDA MODEL PRODUCTION AND CONSERVATION AREA

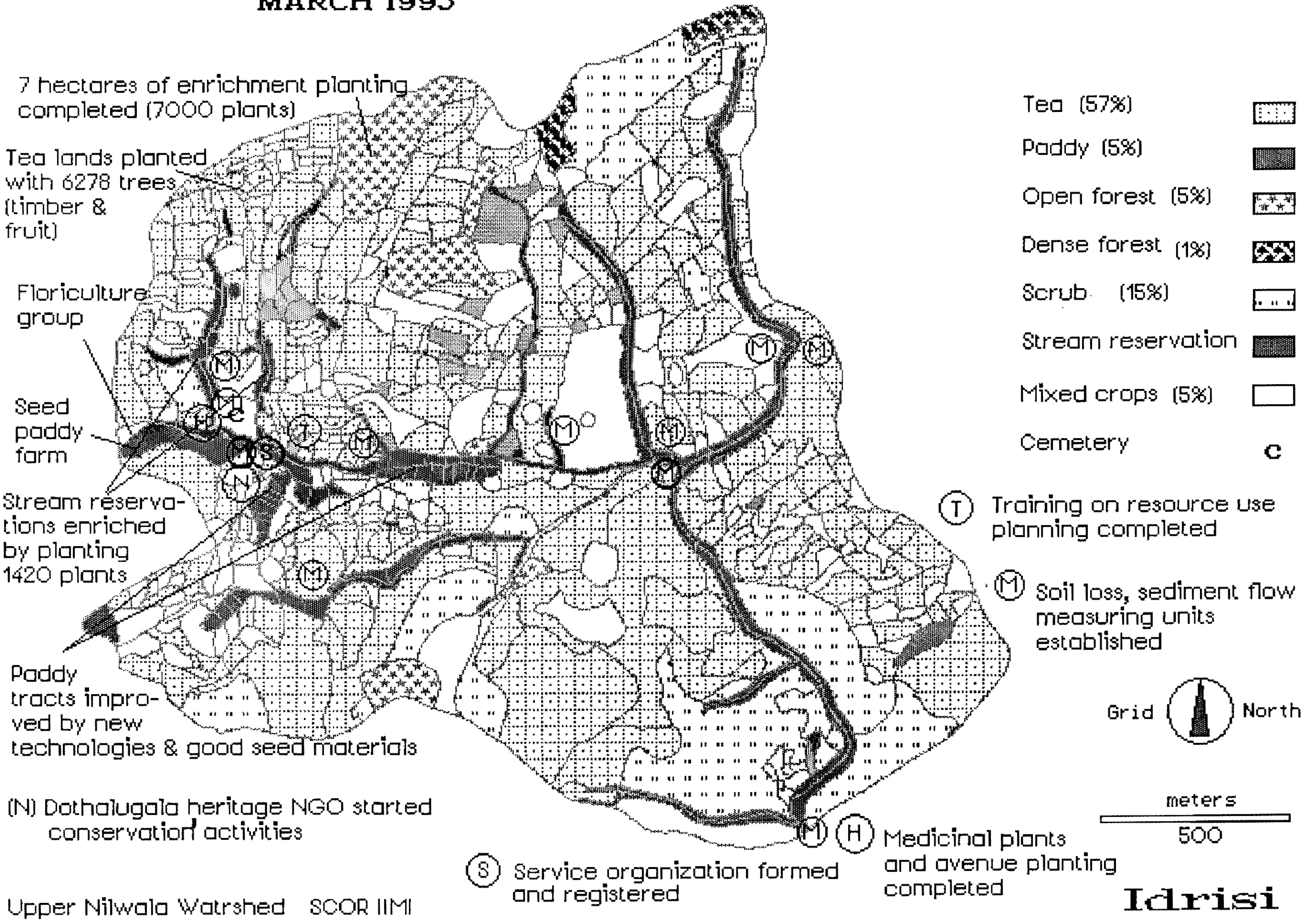
PLANNED FUTURE LANDUSE



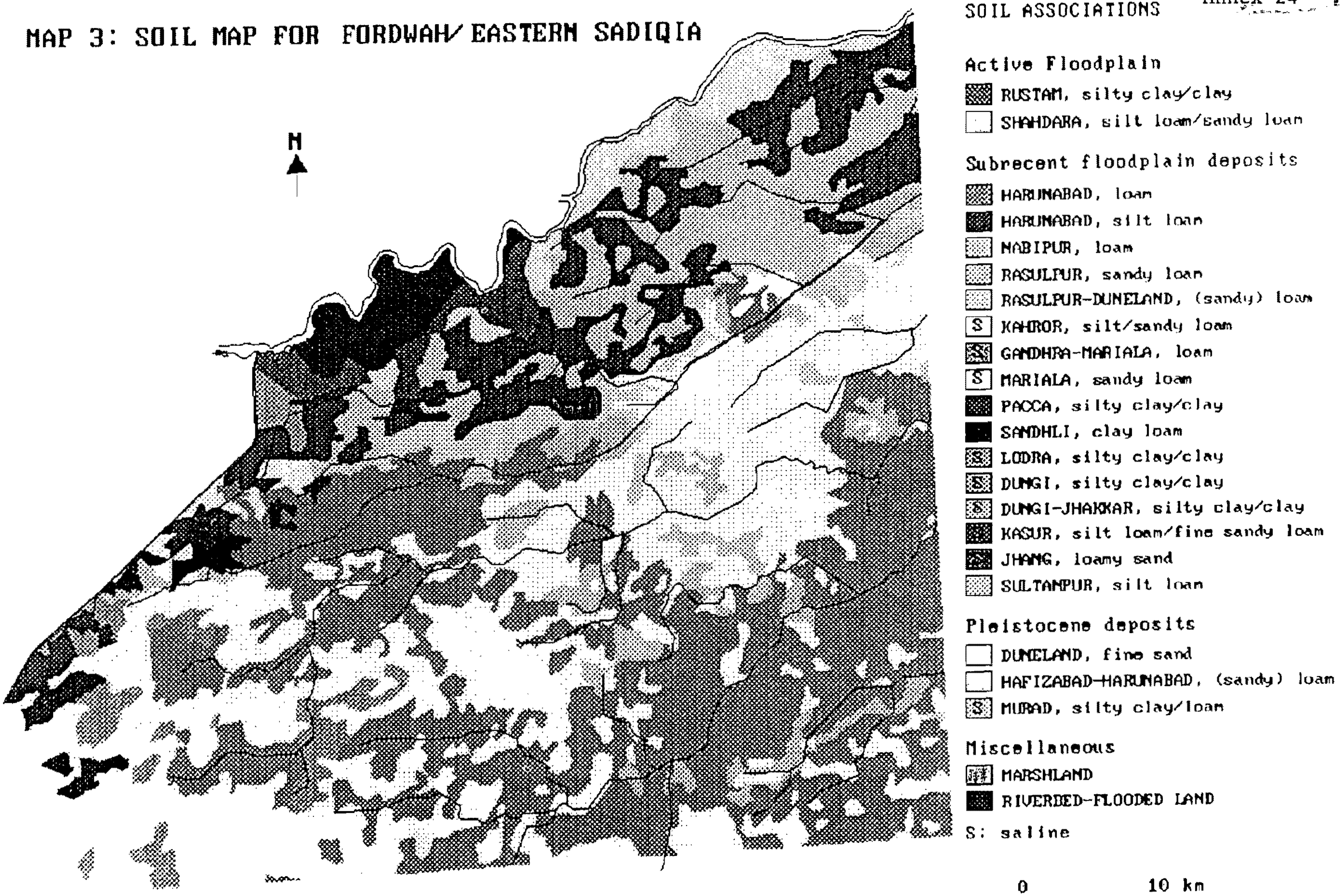
Upper Nilwala Watrshed SCOR IIMI

Idrisi

LAND USE - ANINKANDA MODEL PRODUCTION AND CONSERVATION AREA MARCH 1995

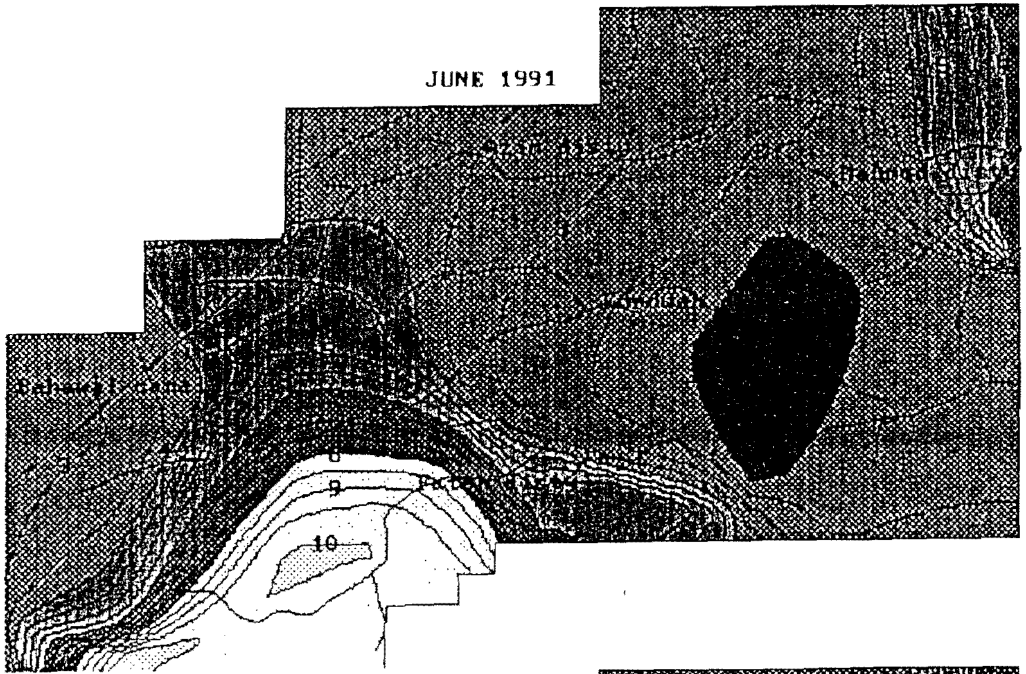


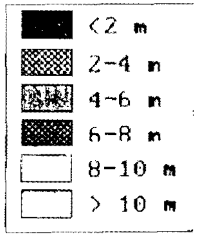
MAP 3: SOIL MAP FOR FORDWAH/EASTERN SADIQIA

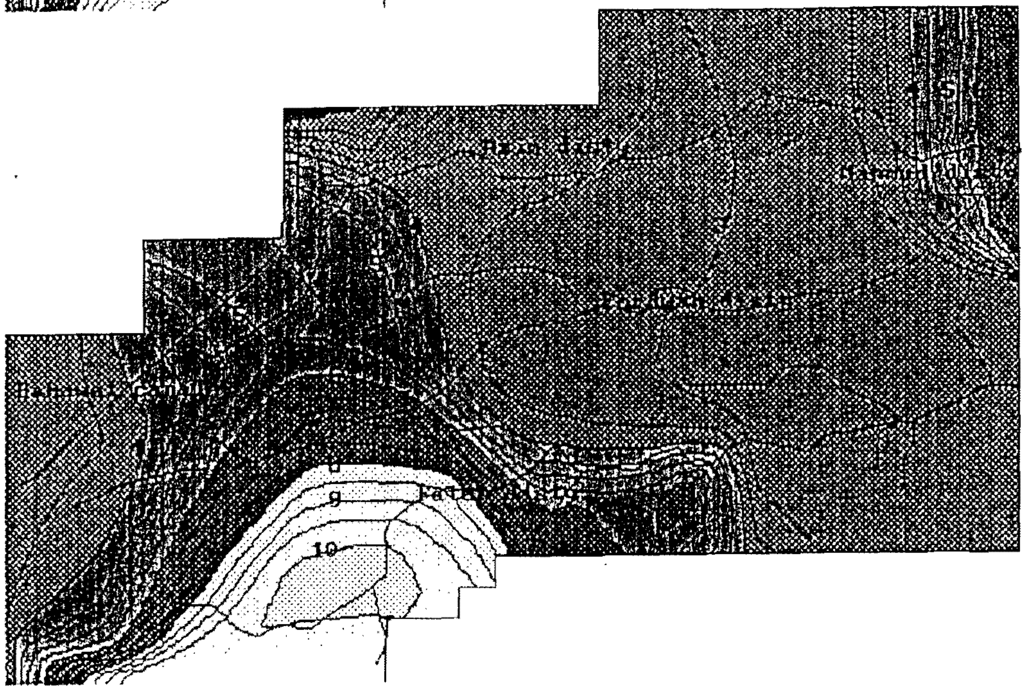


Source: SSoP

MAP 4: GROUNDWATER TABLE DEPTHS, FORDWAH/EASTERN SADIQIA







MAP 2: TUBEWELL DENSITY IN FORDWAH/EASTERN SADIQIA